

A light blue, semi-transparent world map is centered in the background of the slide, showing the outlines of continents and countries.

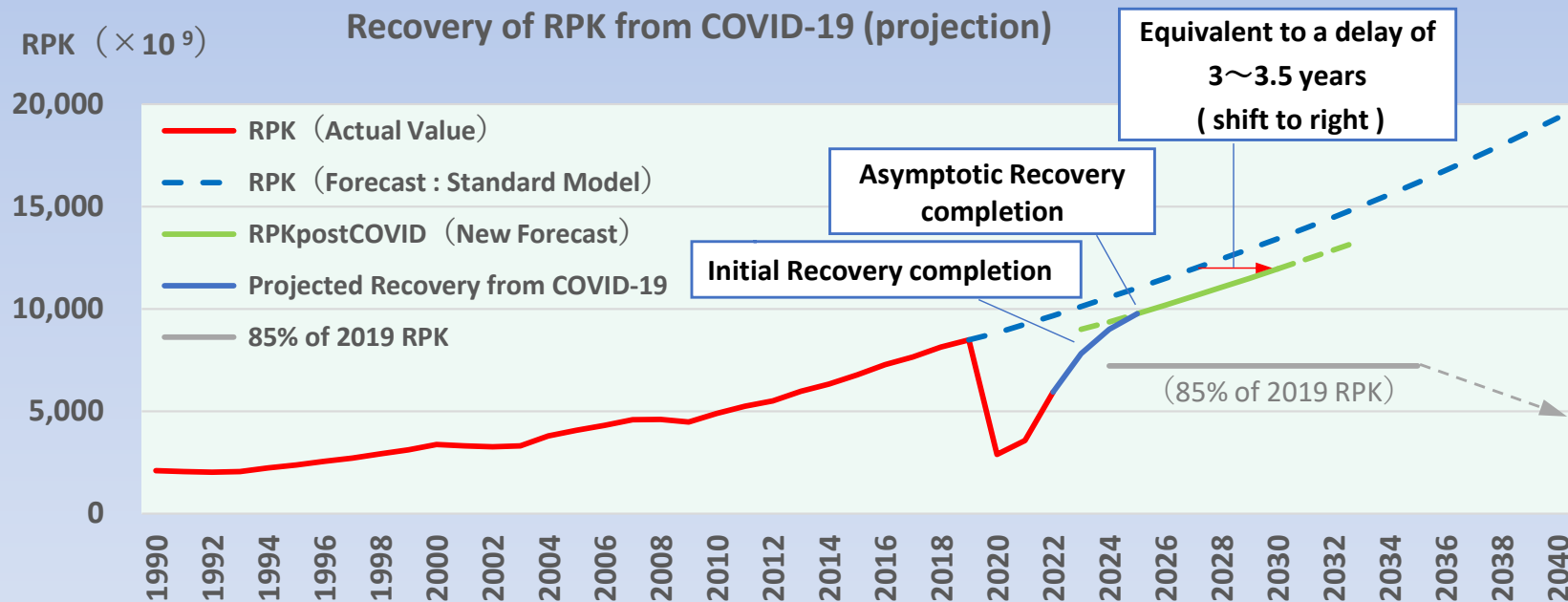
Worldwide Market Forecast (2023 – 2042)

June 2023

Strategic Planning & Market Analysis Department
Japan Aircraft Development Corporation

Briefing (1/4)

- With the vaccination progress in 2021, the RPK in the world has shown its initial recovery in 2022.
- The RPK will exceed 2019 levels by 2024 at the latest and after that, RPK will be affected by CO₂ emission regulations.



Briefing (2/4)

[Recovery from COVID-19]

- In the second half of 2021, GDP and other forecasts were revised upward, and medium- to long-term passenger transport demand forecasts approached pre-COVID-19 levels.
- In 2022, passenger transport demand showed an initial recovery from the damage caused by COVID-19, and the full-year RPKs recovered to 70.6% (IATA) of 2019 levels, as expected.
- Airlines' losses also narrowed significantly and turned profitable in North America. New aircraft orders have recovered to the average level of 2011-2018, and production and deliveries of aircraft were steadily recovering. RPK is expected to exceed the 2019 level by 2024.
- In 2023, the global RPK could reach around 95% of the 2019 level. However, it could be affected slightly downward by slower GDP growth in 2023 and by changes in the calculation criteria for CO₂ offsets scheduled after 2024 in CORSIA.
- At the end of 2022, the global airlines are expected to have a fleet of 25,075 operational jet airplanes, including both those in operation and younger planes in storage. This suggests that airlines have enough planes to fully resume operations after COVID-19.

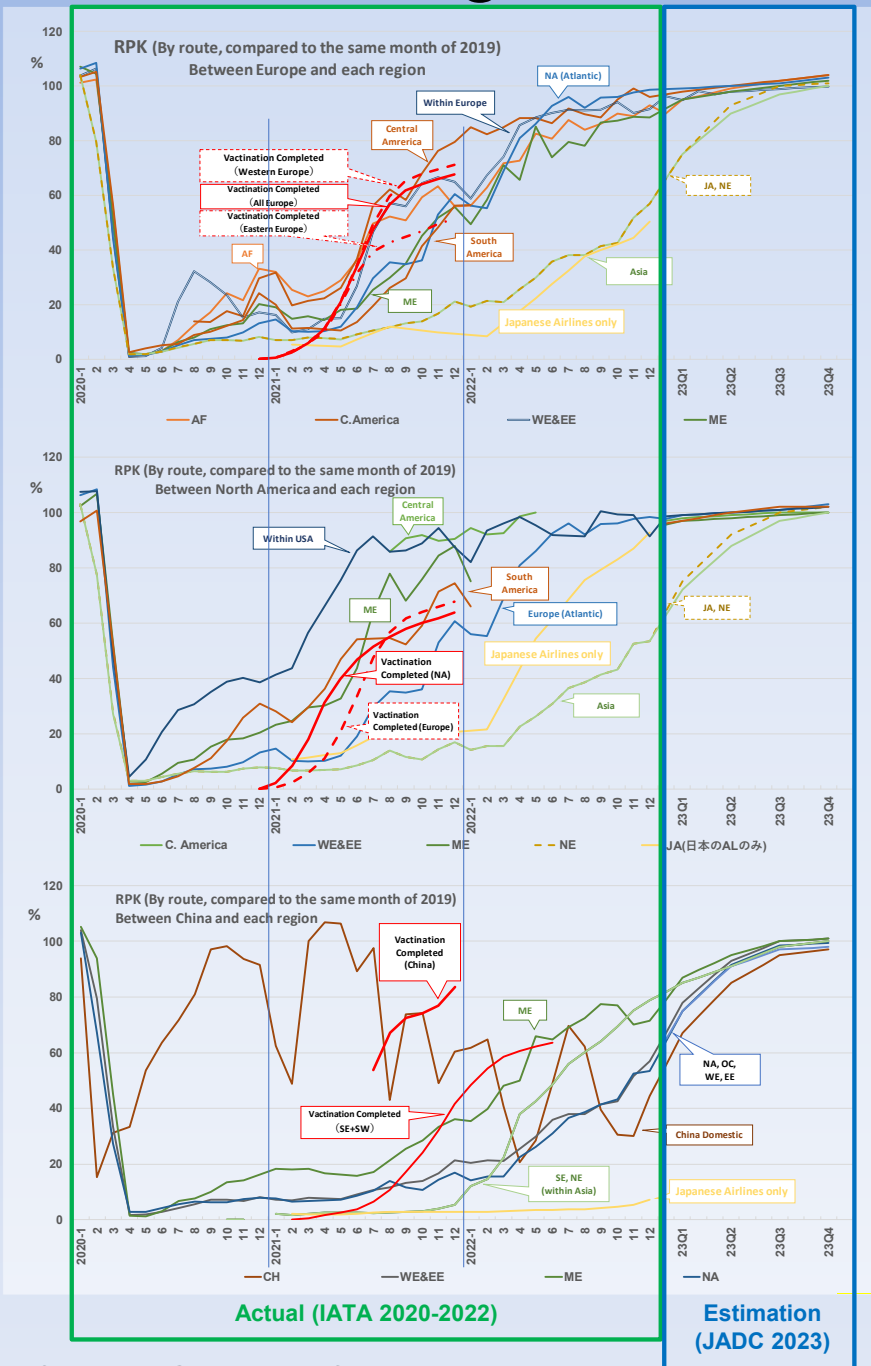
Briefing (3/4)

[Turbulence on the Global Security and Economy]

- The end of the negative effects caused by COVID-19 is in sight. However, since 2022 spring, a series of factors have emerged to impede the stability and growth of the global economy, for example soaring energy prices and food prices and semiconductor shortages and their impact on production activities. Therefore, the economic outlook for 2023 and beyond was revised downward.
- Compared to the 2019 forecast, which was studied before COVID-19, the revised GDP and RPK are expected to lag by 1.5 to 1.8 years and 3 to 3.5 years respectively, in the medium to long term.
- Quantitative calculations for the number of passenger aircraft delivered in the future are based on this revised RPK. The number of jet airliner deliveries over the next 20 years will be approximately 33,400, which is lower than previously projected.
- Furthermore, the prolonged sanctions against Russia will make it impossible to export aircraft to Russia. As a result, the number of passenger aircraft deliveries by Western aircraft manufacturers is expected to decrease by approximately 500 to 1,000 aircraft over the next 20 years, depending on the length of the sanctions period. (Example: $33,400 - 500 = 32,900$)

[Reduction of CO₂ emissions]

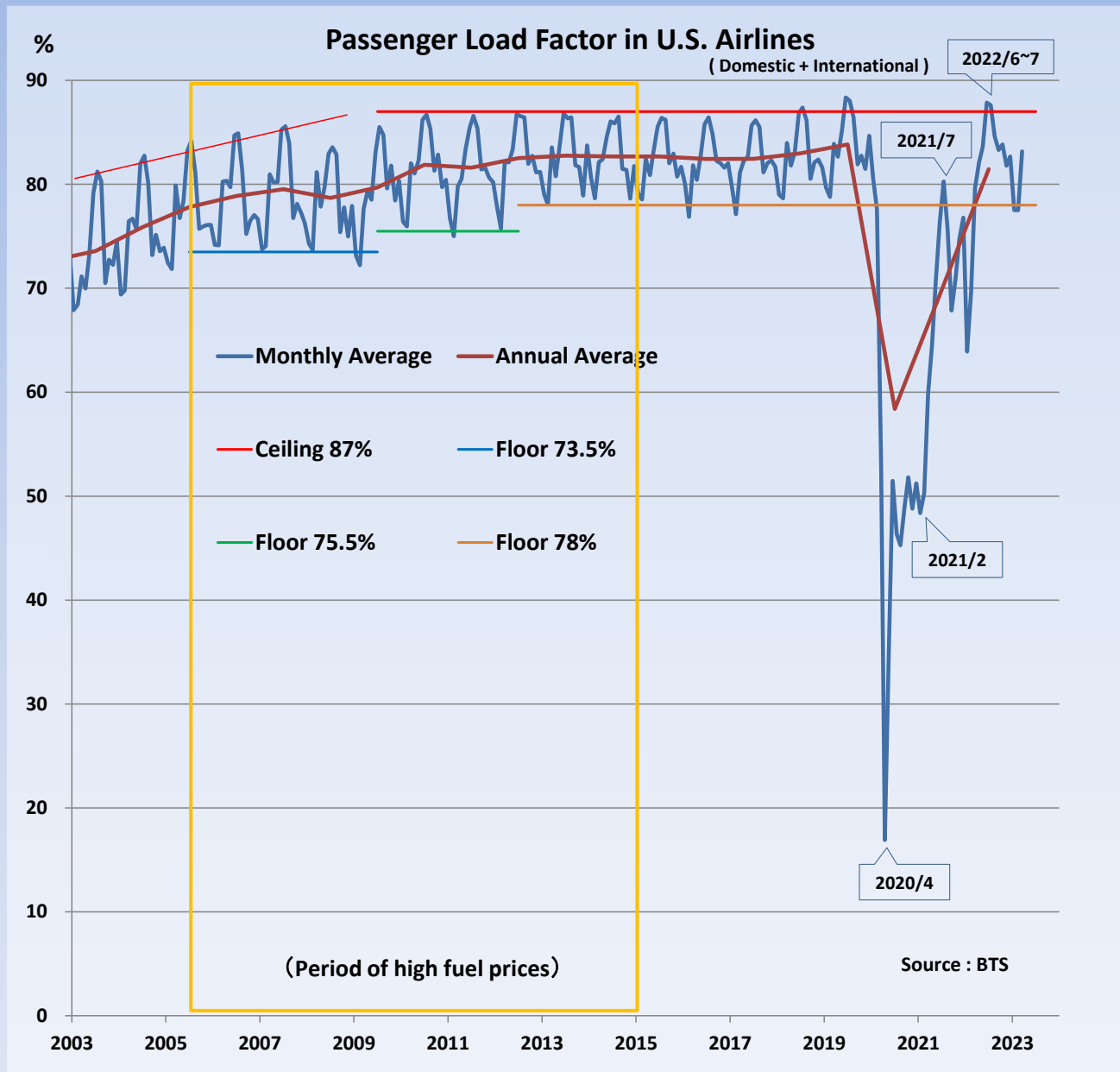
- Furthermore, at the ICAO General Assembly in 2022, a resolution was agreed for global airline industry to set the baseline for CO₂ offsets after 2024 at 85% of 2019 levels.
 - For airlines, while continuing to improve fuel efficiency through fleet renewal, the use of alternative fuels (SAF) in the medium to long term and the use of carbon credits in the short term are expected to be the measures to be taken. However depending on the availability of them, direct restrictions on ASK may occur.
 - Quantitative calculations using price data of these alternative fuels are difficult because of uncertainties about future prices of these fuels. Therefore, a parametric study was conducted using assumed prices.
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- This report^{*1} is a brief version to be excerpted from the full version in Japanese. (*1 : <http://www.jadc.jp/en/data/forecast/>)
 - The full version^{*2} in Japanese has already been published on the JADC website. (*2 : <http://www.jadc.jp/data/forecast/>)



In 2021, with the inoculation of the long-awaited COVID-19 vaccines, the RPK recovery has begun in sync with the progress of vaccination.

Global RPK has shown a clear recovery in 2022 (initial recovery) and will approach 2019 levels in 2023, and exceed it in 2024.

RPK_{2022} had reached 70% of RPK_{2019} .
 RPK_{2023} will be 90 to 95% of RPK_{2019} .



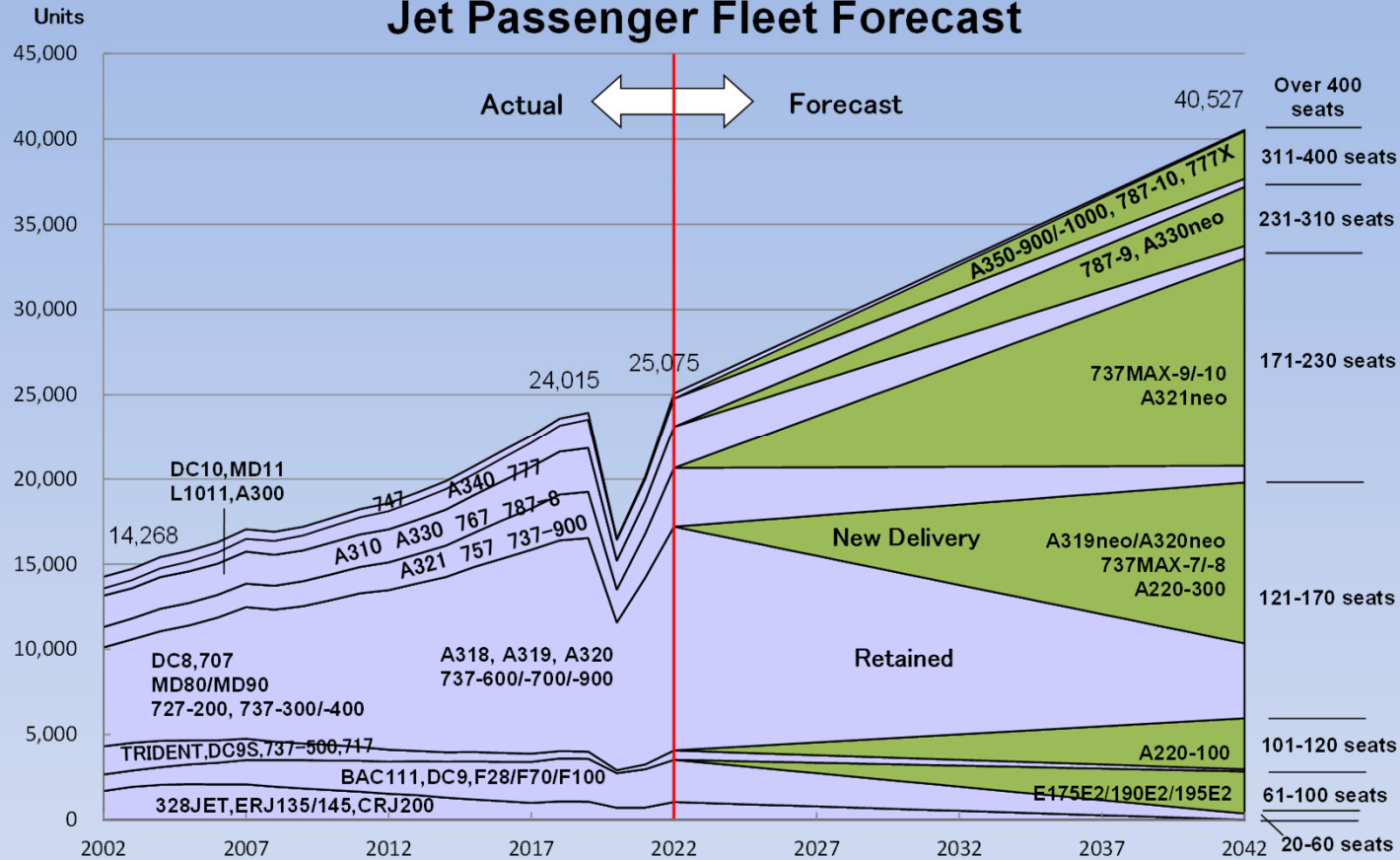
In 2020, COVID-19 caused a sharp drop in passenger demand and in LF.

By the end of 2020, LF had recovered to about 50%, and by the end of 2021, LF had recovered to about 75% as the vaccination progressed .

In the following year, 2022, LF reached 88% from June to July, recovered to the pre-COVID-19 level, and also regained its characteristic shape of seasonality.

Against COVID-19

Jet Passenger Fleet Forecast



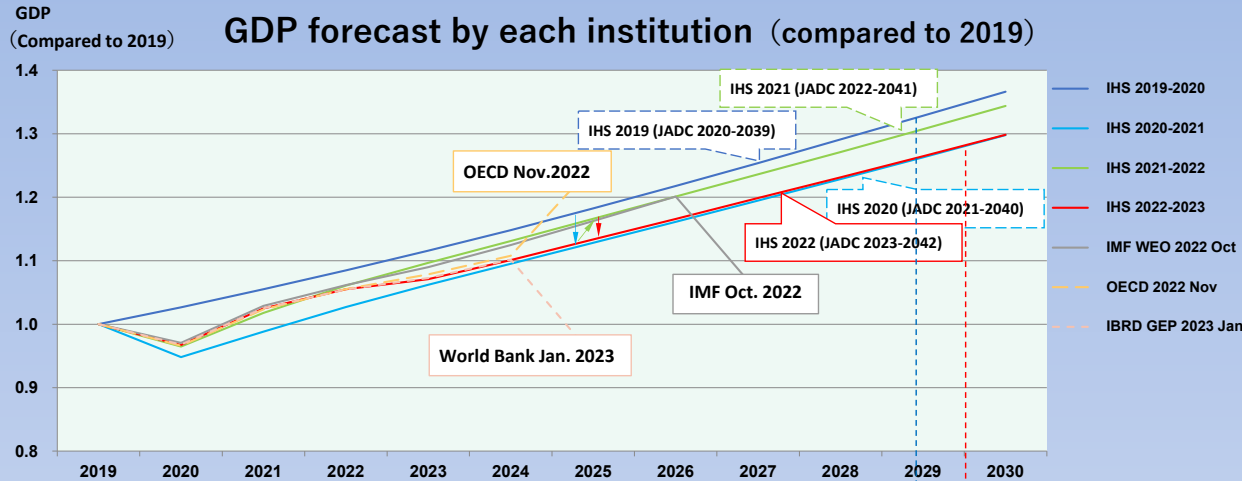
Under COVID-19, airlines made many airplanes grounded and operated a reduced fleet.

Many of the grounded (stored) planes are expected to return to service. In our forecast above, the 25,075 planes in 2022 includes both current in and expected* return to service.

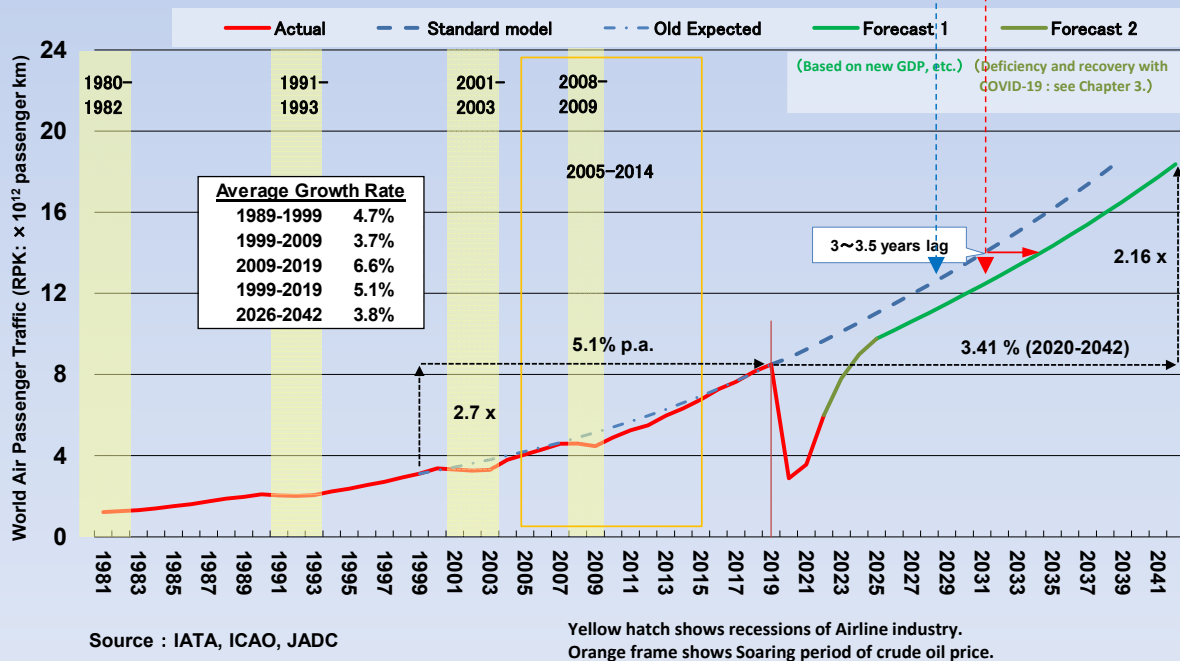
(*: Planes stored after 2020 by COVID-19 pandemic and 737MAX after 2019)

25,075 is more than the 24,015 "in service" at the end of 2019, which means airlines have enough planes to fully resume operations after COVID-19.

Post COVID-19 (Section 3.4)



Trend in World Air Passenger Traffic (RPK)



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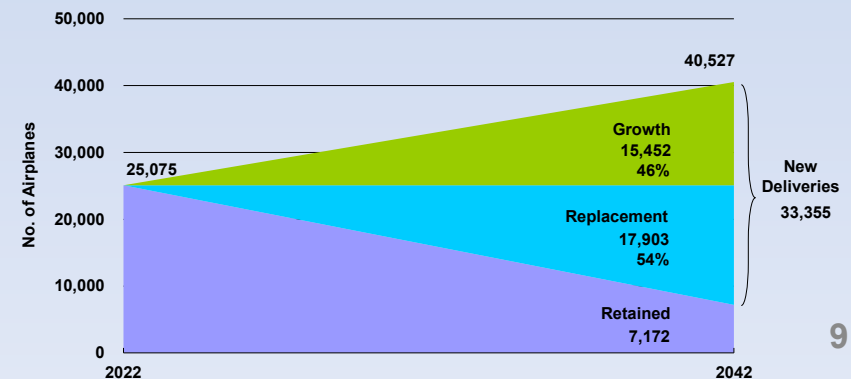
Many institutions have published GDP forecasts, showing a decline from the previous 2021 edition.

JADC uses IHS's GDP forecast, which is about 4 to 5% lower than the GDP forecast before COVID-19. (Fct₁₂₃₄ : Forecasted in 1234)
 (GDP₂₀₂₅ : Fct₂₀₁₉ / Fct₂₀₂₂ = 1.043,
 GDP₂₀₃₀ : Fct₂₀₁₉ / Fct₂₀₂₂ = 1.051)

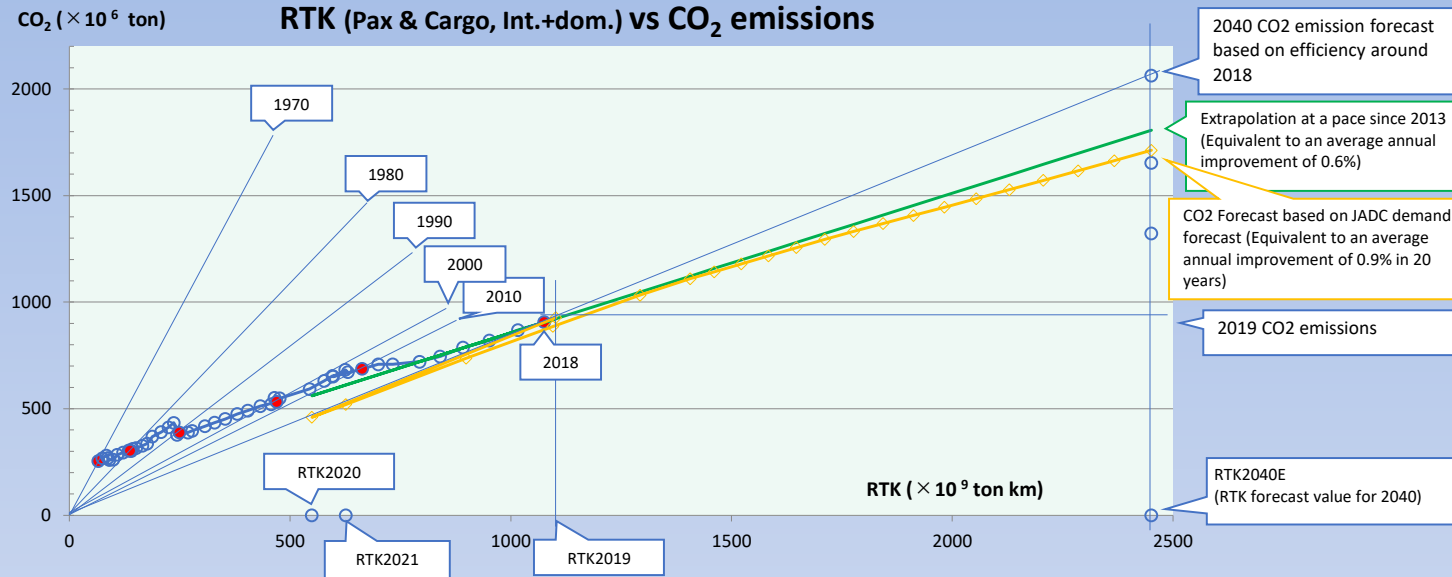
With this new data, we updated our RPK forecast, which is about 12% lower, or 3 to 3.5 years behind, than that made before COVID-19.

(RPK₂₀₂₅ : Fct₂₀₁₉ / Fct₂₀₂₂ = 1.129,
 RPK₂₀₃₀ : Fct₂₀₁₉ / Fct₂₀₂₂ = 1.124)

With this RPK forecast, our projection is that 33.4 thousands passenger jets will be delivered in the next 20 years. This is almost the same level of our 2020 projection, just before COVID-19 pandemic.



Examining the impact of CO₂ emission credit burden (Section 5.3.1)



Airlines have been working to reduce fuel consumption for a long time and have achieved great improvement, but in the future, further improvement is required to reduce CO₂ emissions.

Airlines will continue to introduce new airplanes with better fuel efficiency, but this will contribute to 0.9% CO₂ emissions reduction per year on average.

Therefore, alternative fuels and other measures are imperative.

(For the calculations in Sections 5.3.1.1 through 5.3.1.3, we used the RPK forecast at the end of 2021 which has an average growth rate of 3.98%. It is somewhat conservative condition with respect to CO₂ reduction requirements.)

Examining the impact of AF burden (Section 5.3.1.4)

Governments of major countries are accelerating their steps to reduce CO₂ emissions.

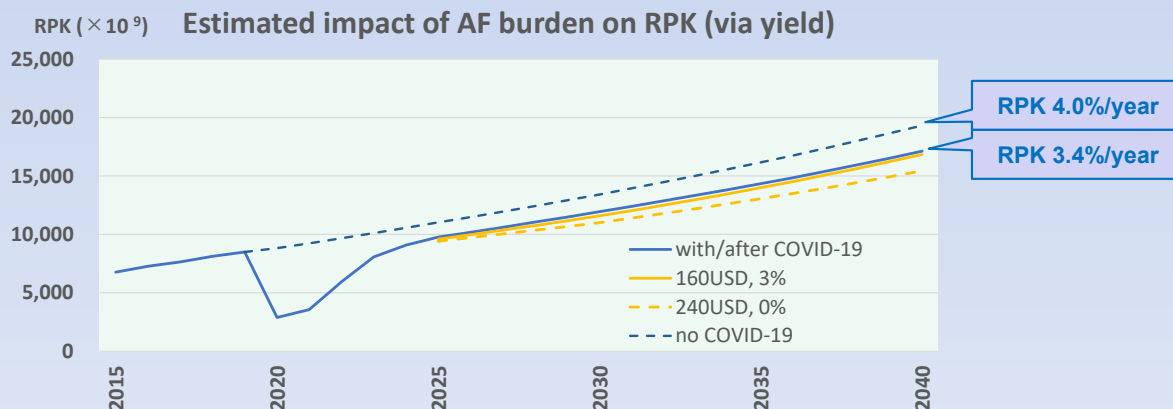
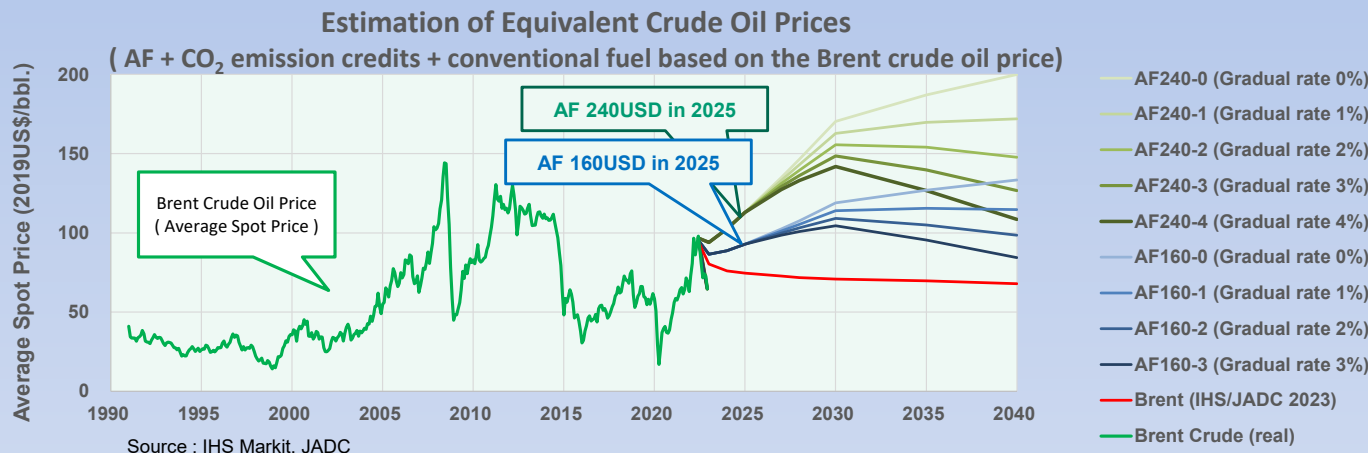
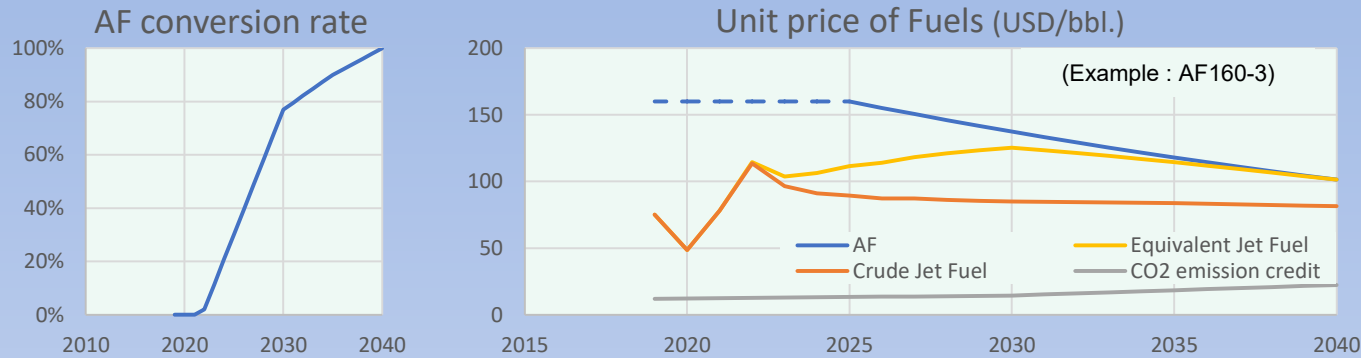
This page are on the assumption that airline CO₂ emissions will be reduced by half from the current level by 2030.

In 2030, 80% of jet fuel need to be Alternative Fuels (AF)*, and this volume is equivalent to 113% of the Jet Fuel supplied in 2019.

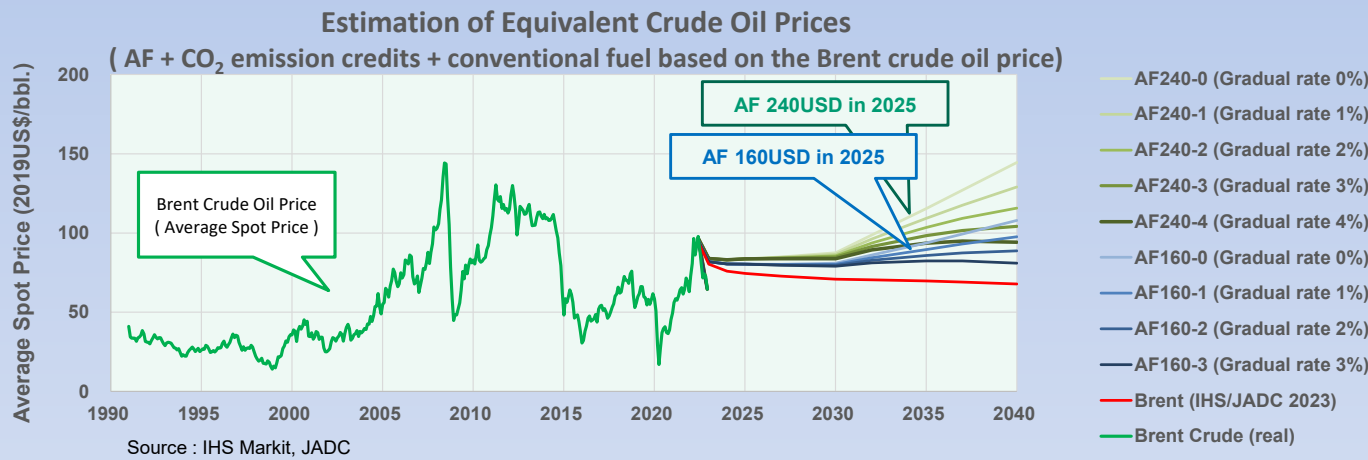
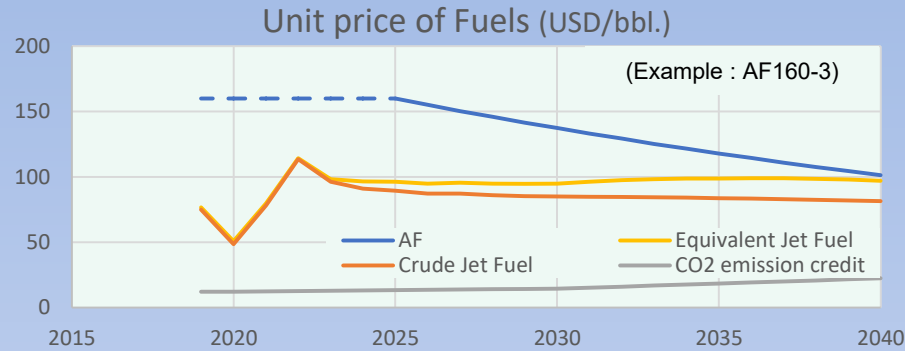
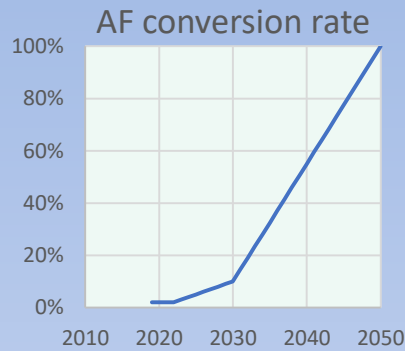
Alternative fuels are expected to be expensive. In order to prevent the burden on the aviation industry and users from increasing, it is necessary to secure sufficient supply of AF and reduce the price, by sufficient investments.

(* : 'Alternative fuels' means e-Fuel or SAF etc.)

(** : With the contribution of vaccines, etc., the recovery of GDP and RPK is expected to be accelerated, and CO₂ emissions in 2030 are also expected to increase than the previous forecast.)



Examining the impact of AF burden (Section 5.3.1.4)



In another case, for example, some airlines have stated that they will use 10% alternative fuels (AF) in 2030.

In this case, the annual usage of AF in the 2020s is not huge, and the impact of expensive AF on fares is relatively small.

To supply AF to meet the goal, 10% in 2030, 1.3% annual AF production increase is required in 2020s.

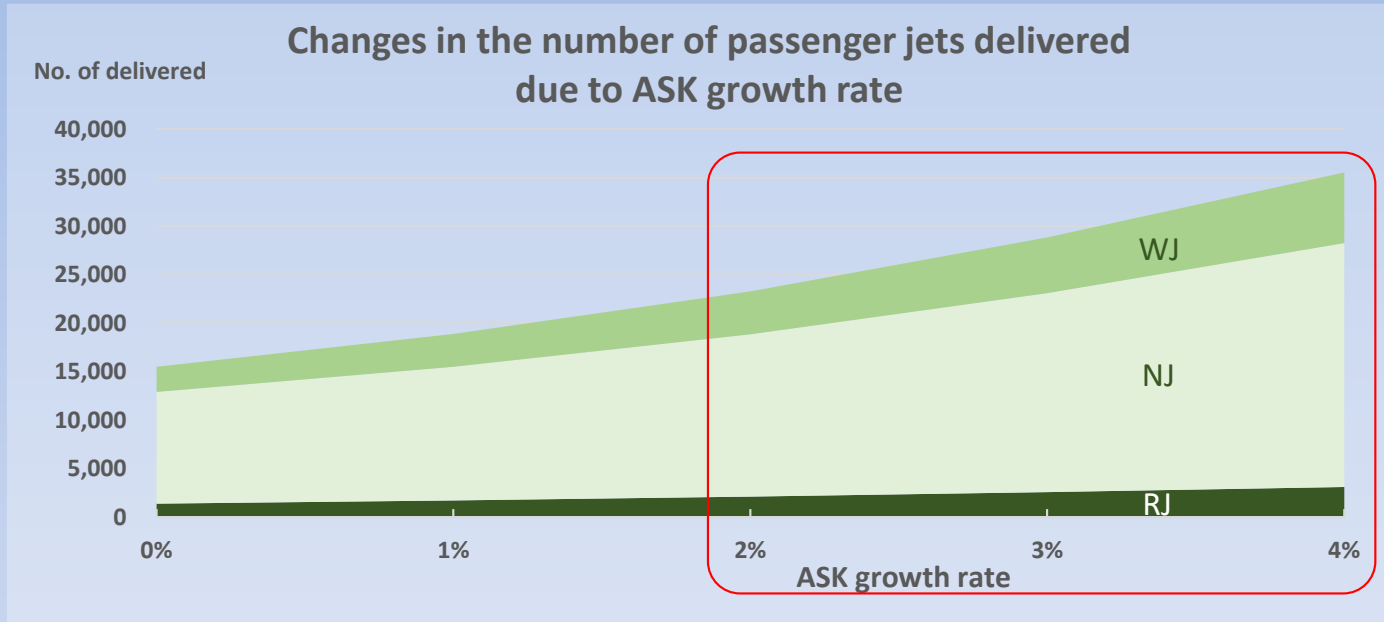
By replacing old airplanes with newly built fuel efficient airplanes, CO₂ emissions can be reduced by 0.9% annually.

Combined with the above-mentioned*, it is equivalent to reducing CO₂ emissions at an average annual pace of about 2%. (* Page 9)

The average growth rate of RPK for the next 20 years derived from GDP etc. is predicted to be 4%** , therefore it is necessary to make up for the gap between 4% and 2% by some means in order not to constrain the growth of airlines.

(** just before COVID-19)

Impact of CO₂ reduction on ASK and Deliveries (Section 5.3.1.4)



In a situation where a reduction of CO₂ emissions is mandatory, CO₂ reductions will have an impact on ASK growth, which in turn will have an impact on the number of aircraft deliveries. Based on this relation, we forecast the number of aircraft deliveries over the next 20 years.

Methodology : Assuming that CO₂ emissions are proportional to the size of ASK, the rate of reduction of CO₂ per unit ASK leads to the rate of increase in ASK under the assumption that total CO₂ emissions are fixed at a constant value.

With 4% of ASK growth rate case, 35.5 thousands new jet planes will be delivered in the next 20 years, and this case needs 4% of CO₂ emission reductions per year. Similarly, only 23.3 thousands planes with 2% case.

We believe it is necessary to supply sufficient and more affordable Alternative Fuels, and for that purpose, it is important to make sufficient investment in a timely manner for the future prosperity of the aviation industry.

- Jets and turboprop covering
 - ✓ Passenger jet 20 seats and above
 - ✓ Passenger turboprop 15 seats and above
 - ✓ Jet freighter
- Regions of the world
 - ✓ 13 regions (passenger)
North America, Latin America, Western Europe, Eastern Europe, Middle East, Africa, Japan, China, Northeast Asia, Southeast Asia, South Asia, Oceania and CIS
 - ✓ 7 regions (freighter)
North America, Latin America, Europe, Middle East, Africa, Asia-Pacific and CIS
- Including scheduled and non-scheduled flight

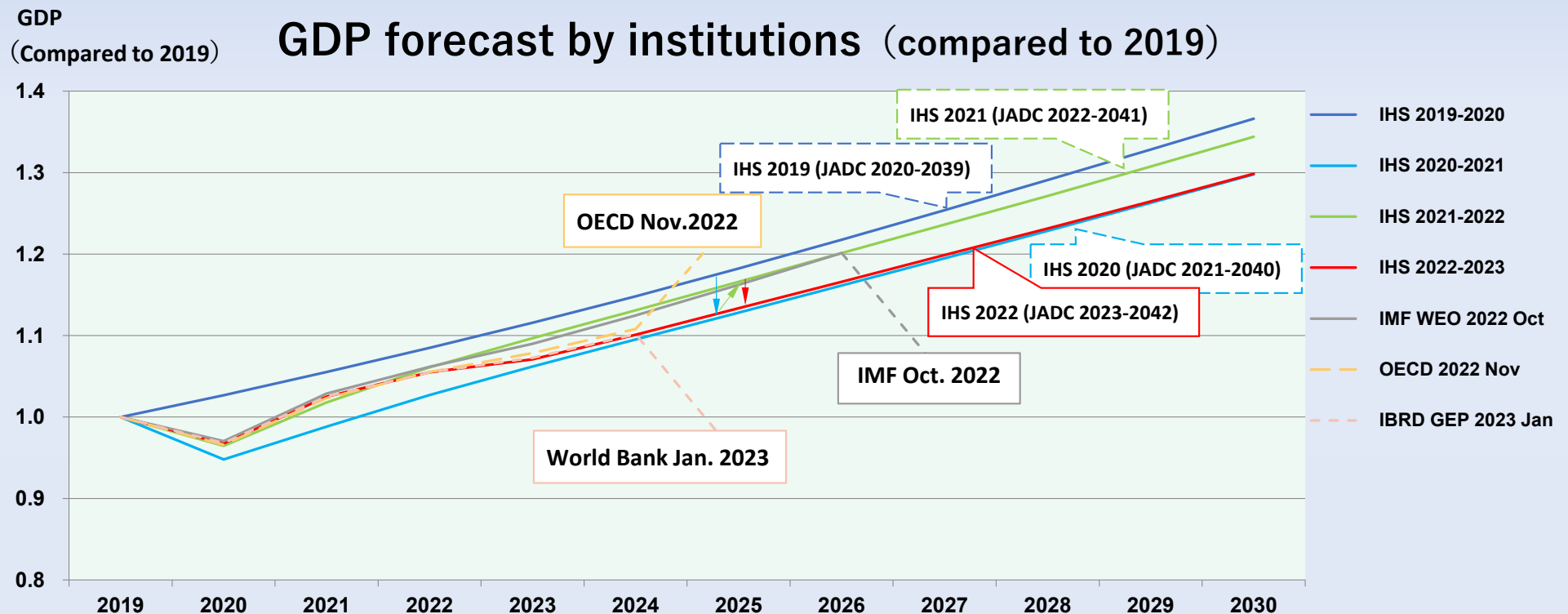
World Economic Forecast

By 2021, the world began to regain its vitality with the practical and widespread use of vaccines, and GDP projections were revised upward, approaching pre-COVID-19 levels.

However, from the spring of 2022 onward, the world's economies and industrial sectors were disrupted by soaring energy and food prices and shortages in the supply of semiconductors.

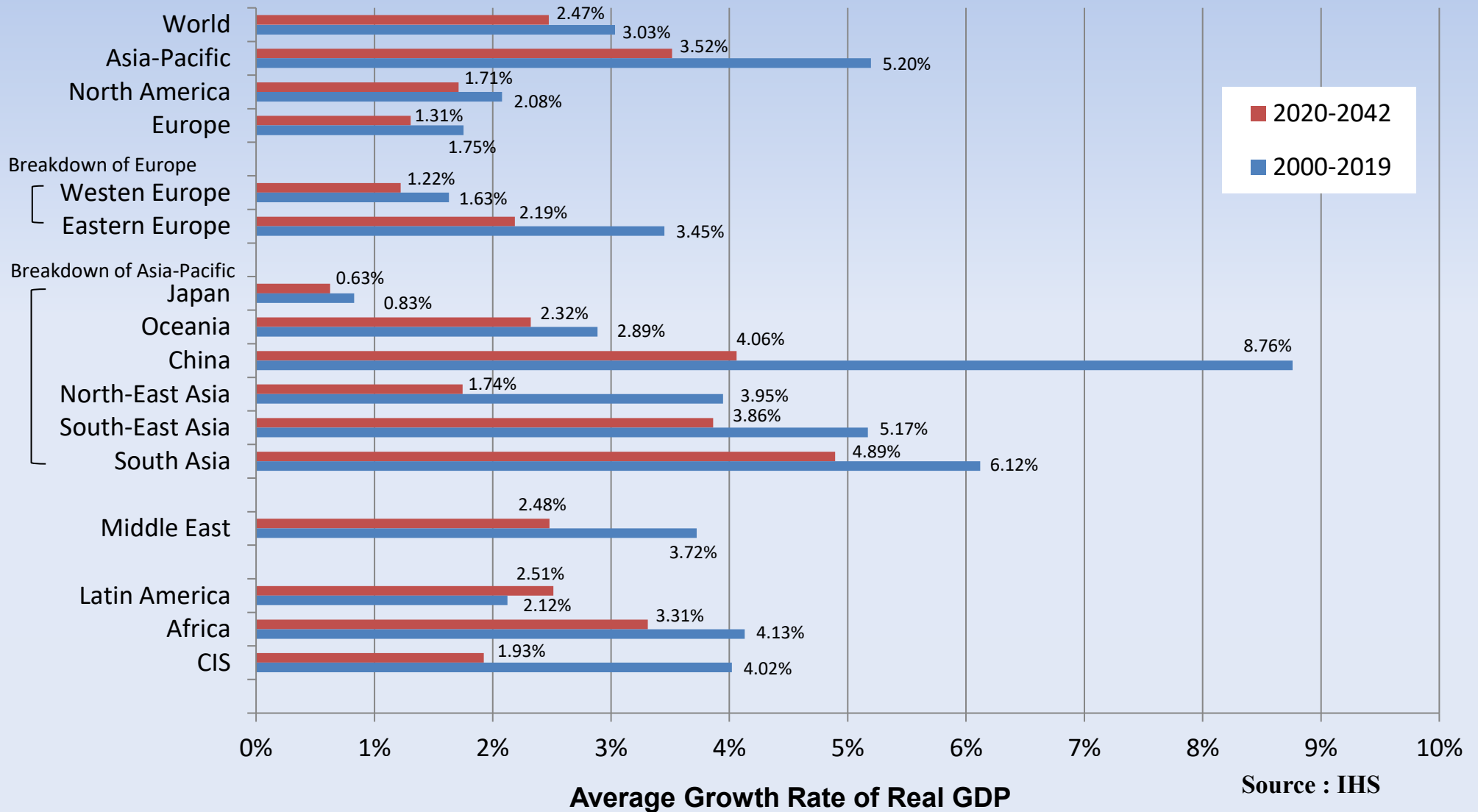
GDP projections released around the end of 2022 shows that GDP growth is expected to be low in 2023, with recovery expected from 2024 onward. However, the stagnation in 2023 will not be resolved and will have lasting effects.

In the medium to long term, the GDP forecast can be seen as 4 to 5% lower than the pre-COVID-19 forecast, or 1.5 to 1.8 years behind.



World Economic Forecast by Region

Global Economy (Real GDP) to grow by 2.47% per year.



Crude Oil Prices and effects on RPK

The oil prices have heavy impact on RPK.

Crude oil prices are expected to be stable over the long term.

However, the forecast price level has risen due to uncertainty of natural gas supply after 2021 and the impact of the invasion of Ukraine.

(Moreover, the cost for reducing CO₂ emission will be a primary burden on yield in future.)

Transition and Forecast of Crude Oil Prices (Brent Crude Oil)

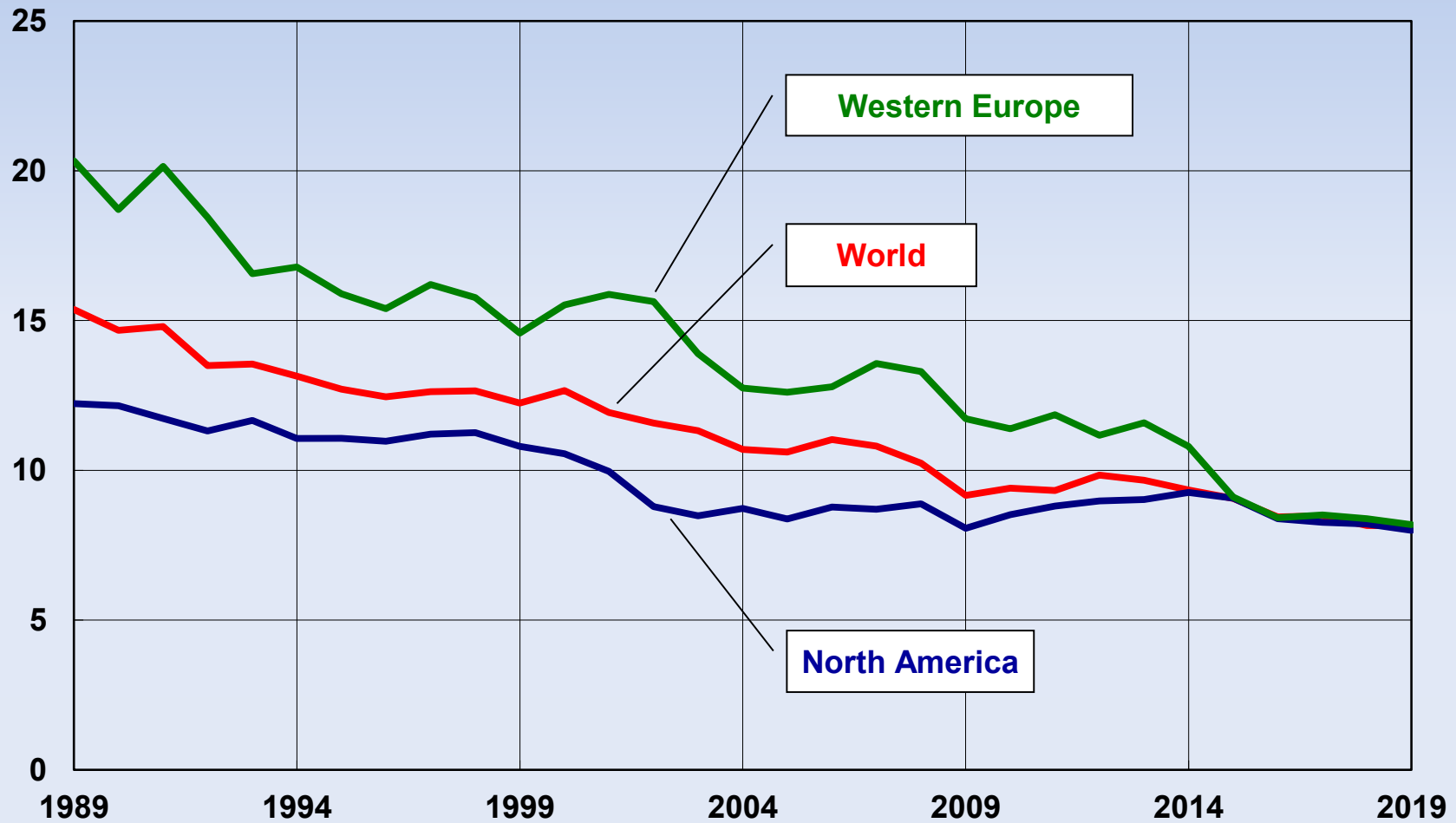


A light blue, semi-transparent world map is centered in the background of the slide, showing the outlines of continents and countries.

Air Passenger Traffic and Passenger Fleet Forecast

Based on the data, the real passenger yields so far have been declining by an average of 0.8% per year.

2015 US cent/RPK

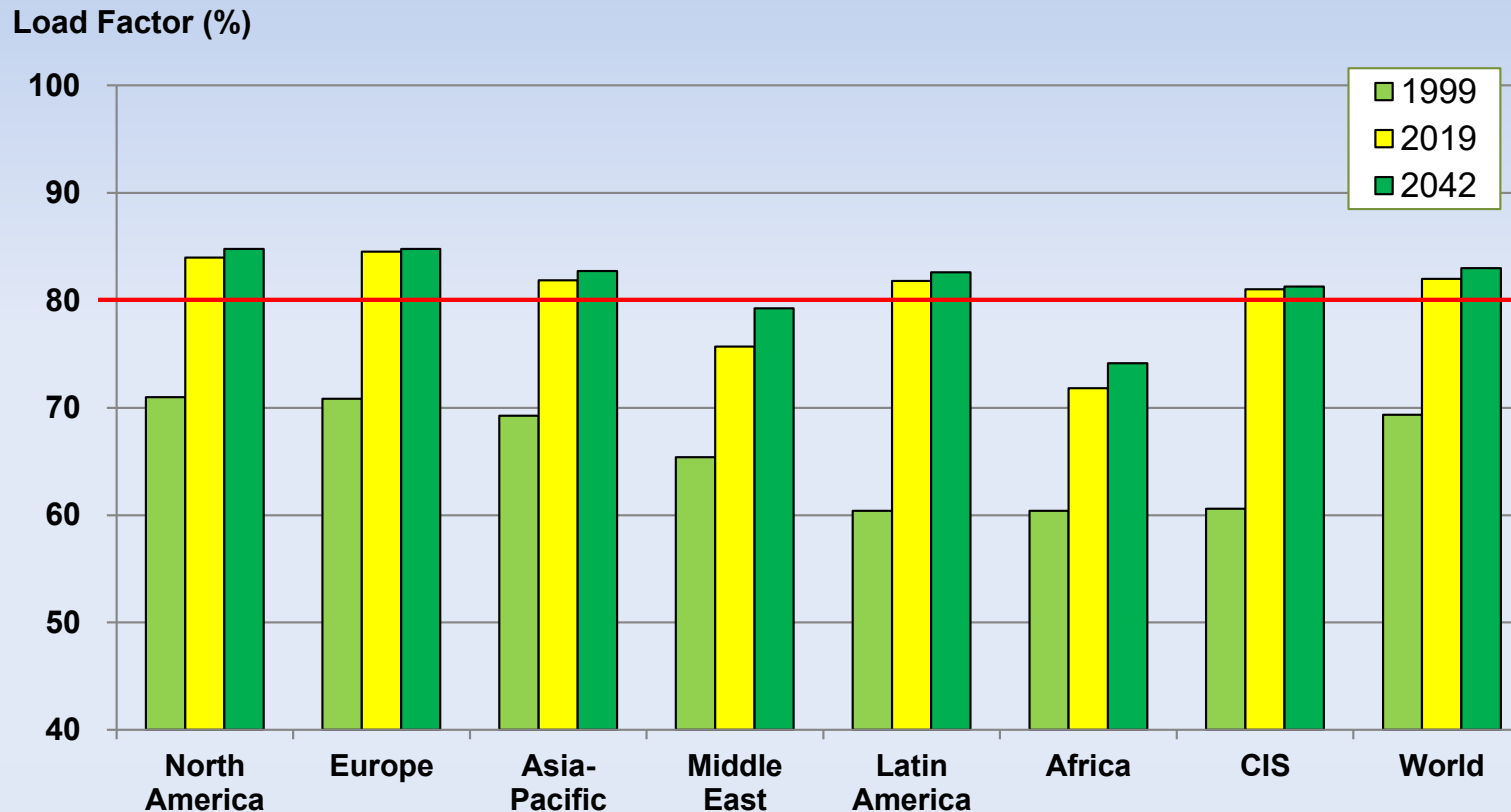


source: AEA, A4A, ICAO, IATA, CIRIUM

This analysis uses actual data up to 2019 as a reference.

Development of Load Factor

Pax. LF had risen rapidly in the past 20 years, reaching an average of 82.0% in 2019 and to reach 83% in 2042.

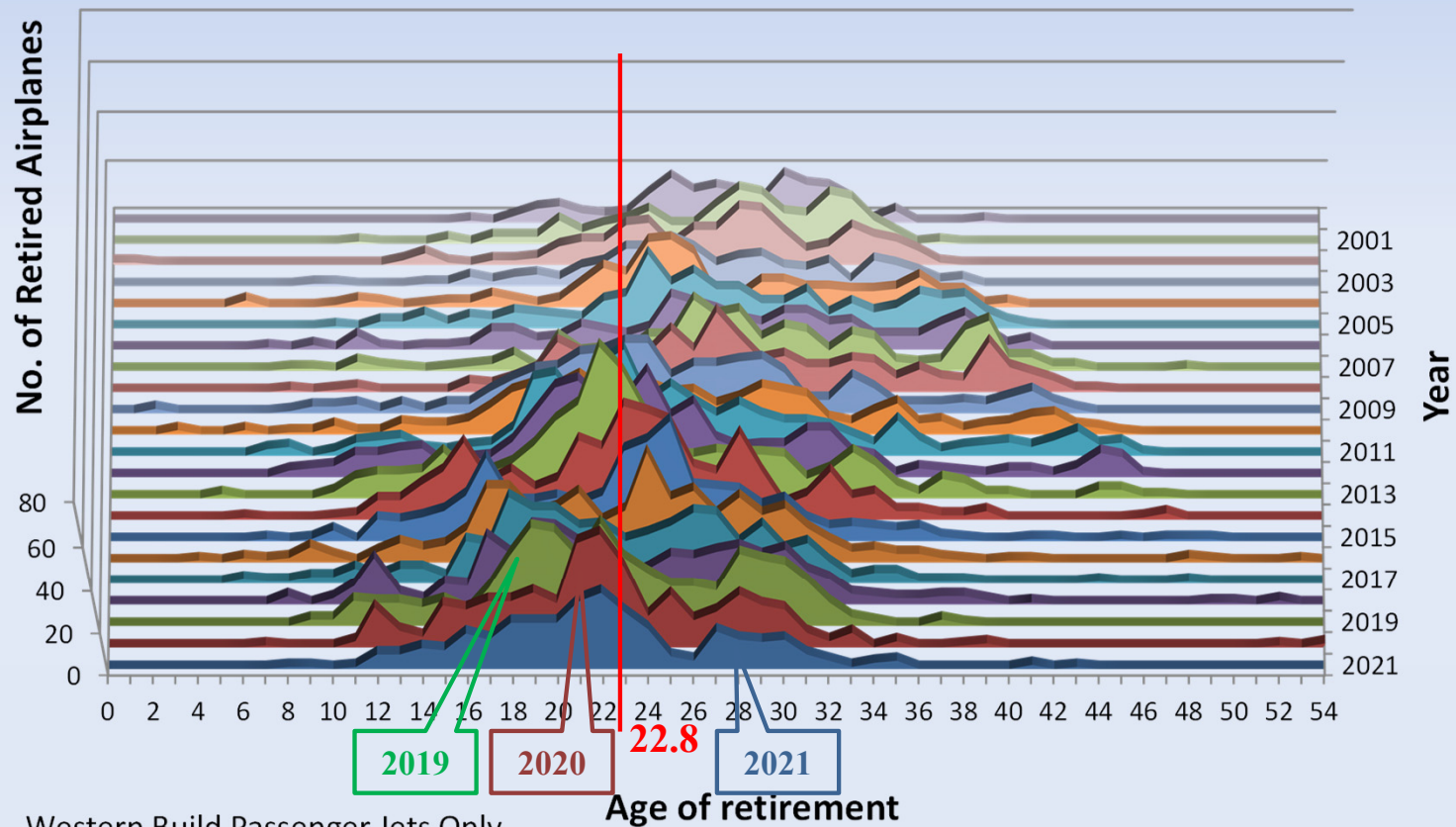


This analysis uses actual data up to 2019 as a reference.

Trend of Retirement (Passenger Jet)

Averaged age of passenger jet retirement is 22.8 in 2019.
 After 2020, a large number of aircraft were forced to retire.

(Every year, it takes time to mature the database of retired airliners. Therefore,
 The final aggregated values for airliners retired after 2020 are expected to increase further.)



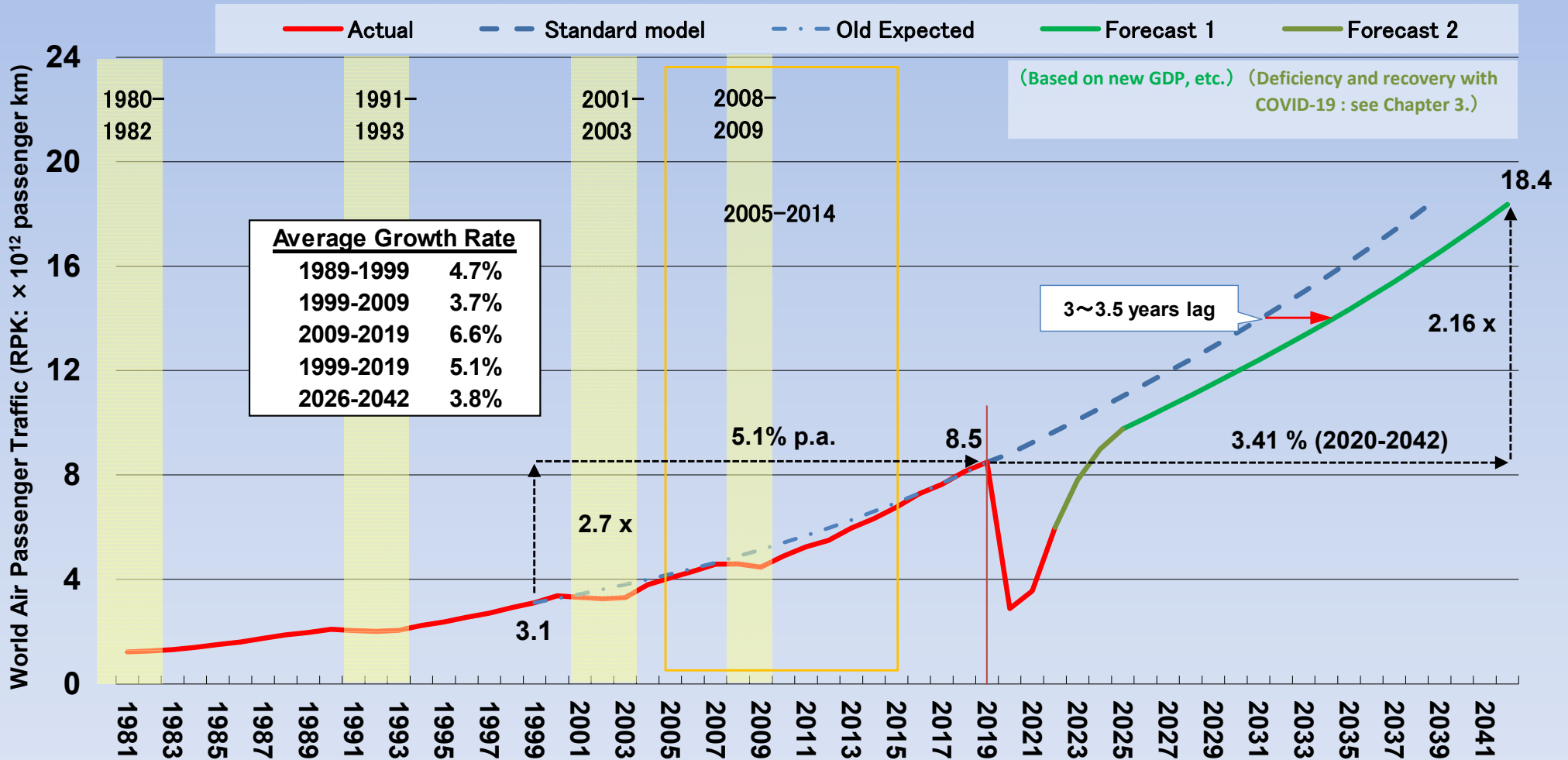
Western Build Passenger Jets Only

Source : CIRIUM

This analysis uses actual data up to 2019 as a reference.

[RPK] World Passenger Traffic Forecast

Global RPK to grow at an average of 3.41% per year through 2042.
It will have a lag of 3 to 3.5 year behind the prediction made before COVID-19.

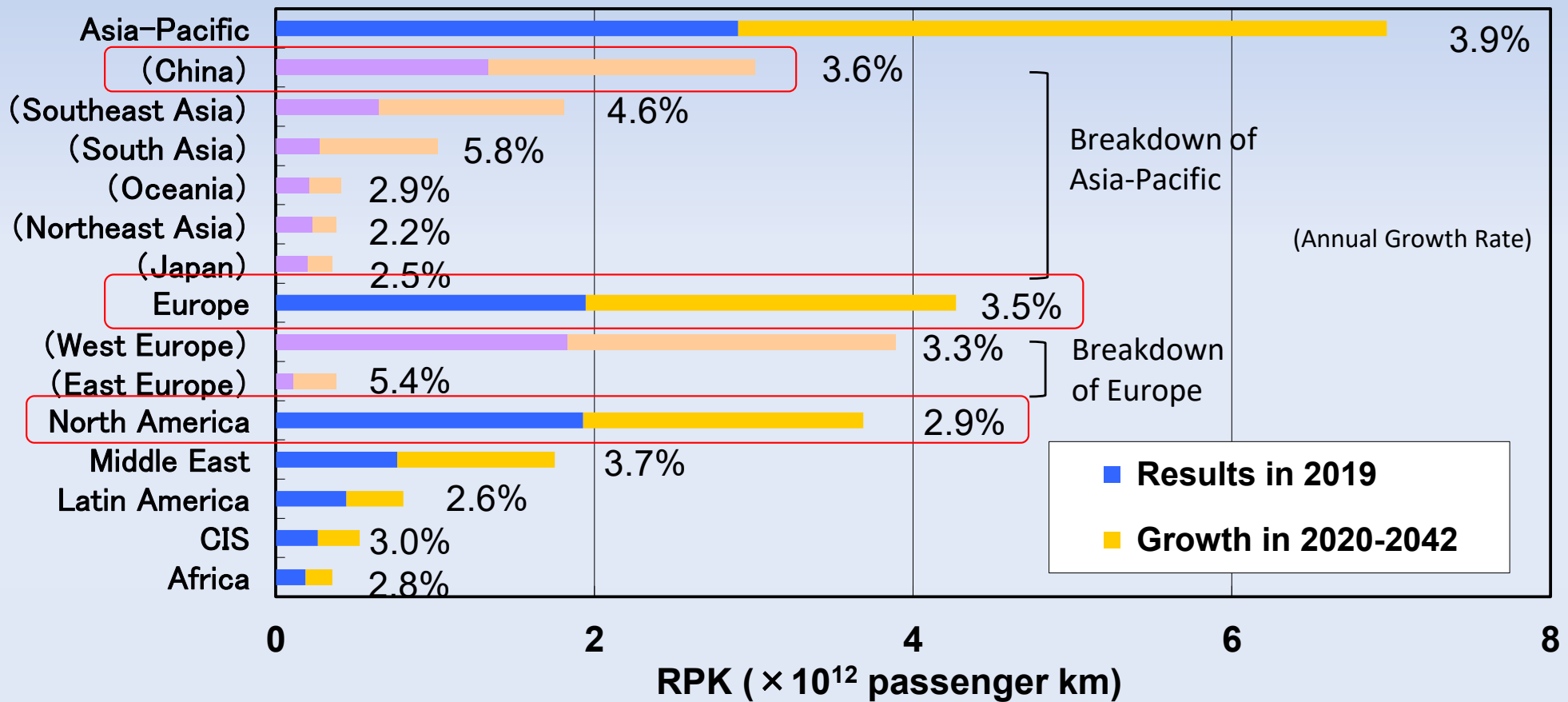


Source : IATA, ICAO, JADC

Yellow hatch shows recessions of Airline industry.
Orange frame shows Soaring period of crude oil price.

[RPK] Passenger Traffic Forecast by Region (2020 - 2042)

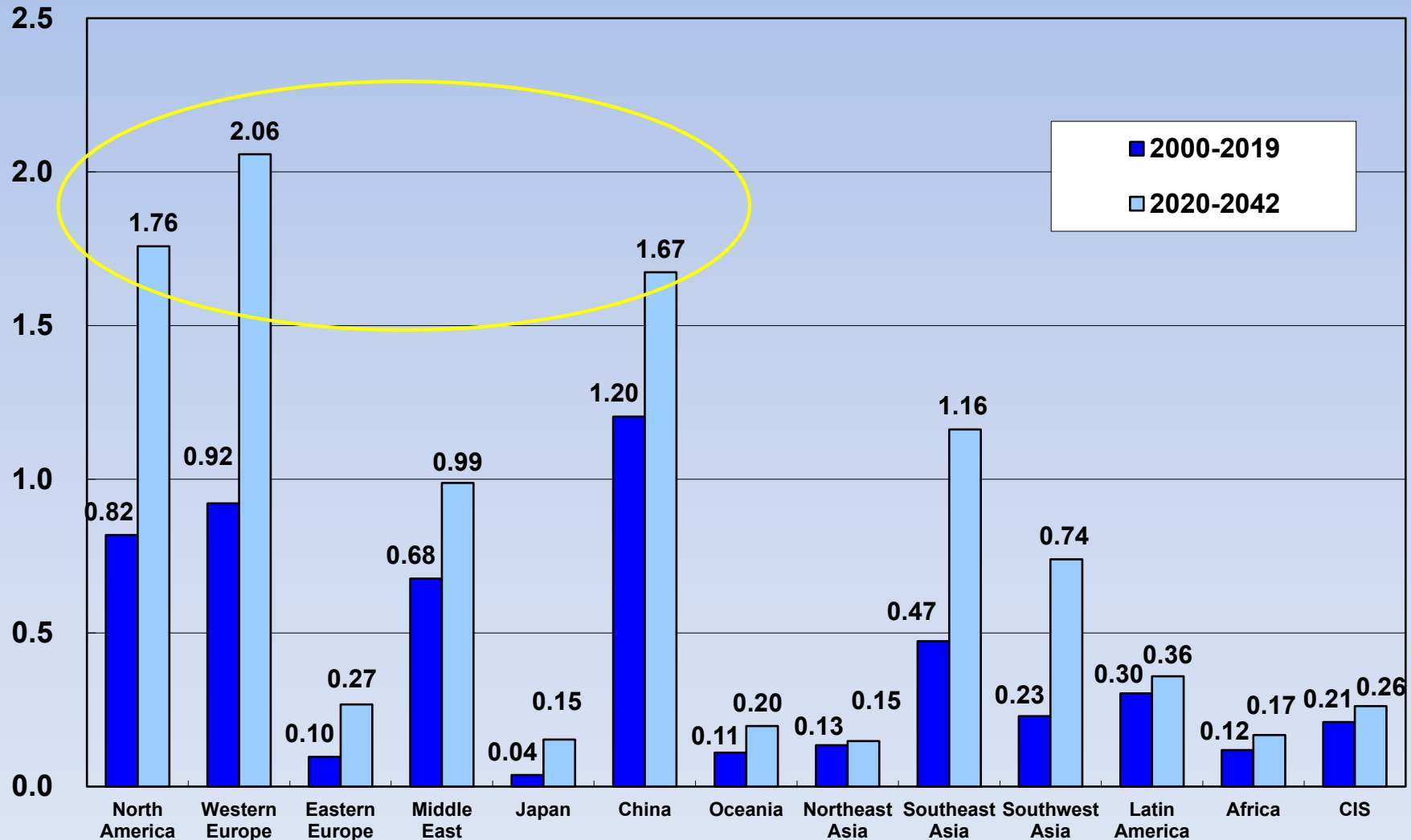
Europe, North America and China to constitute three pillars in RPK of the world.



[RPK] Increment by Region (2020 - 2042)

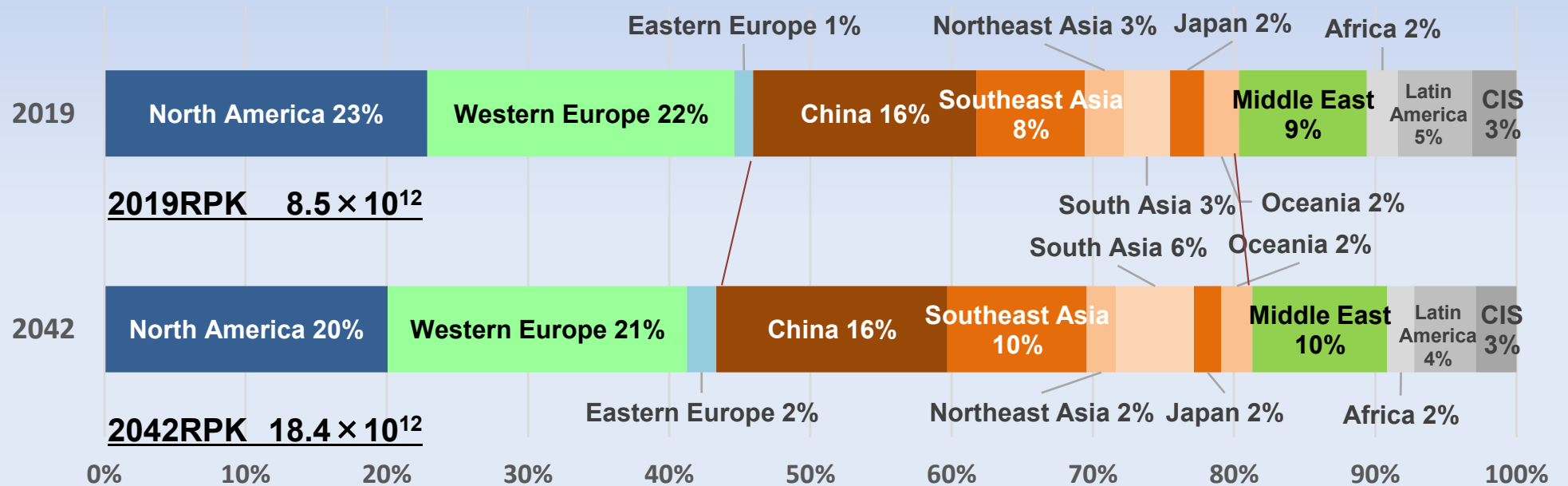
The increment of Europe, North America and China to be still large.
Middle East and Southeast/Southwest Asia to follow.

RPK increment ($\times 10^{12}$)



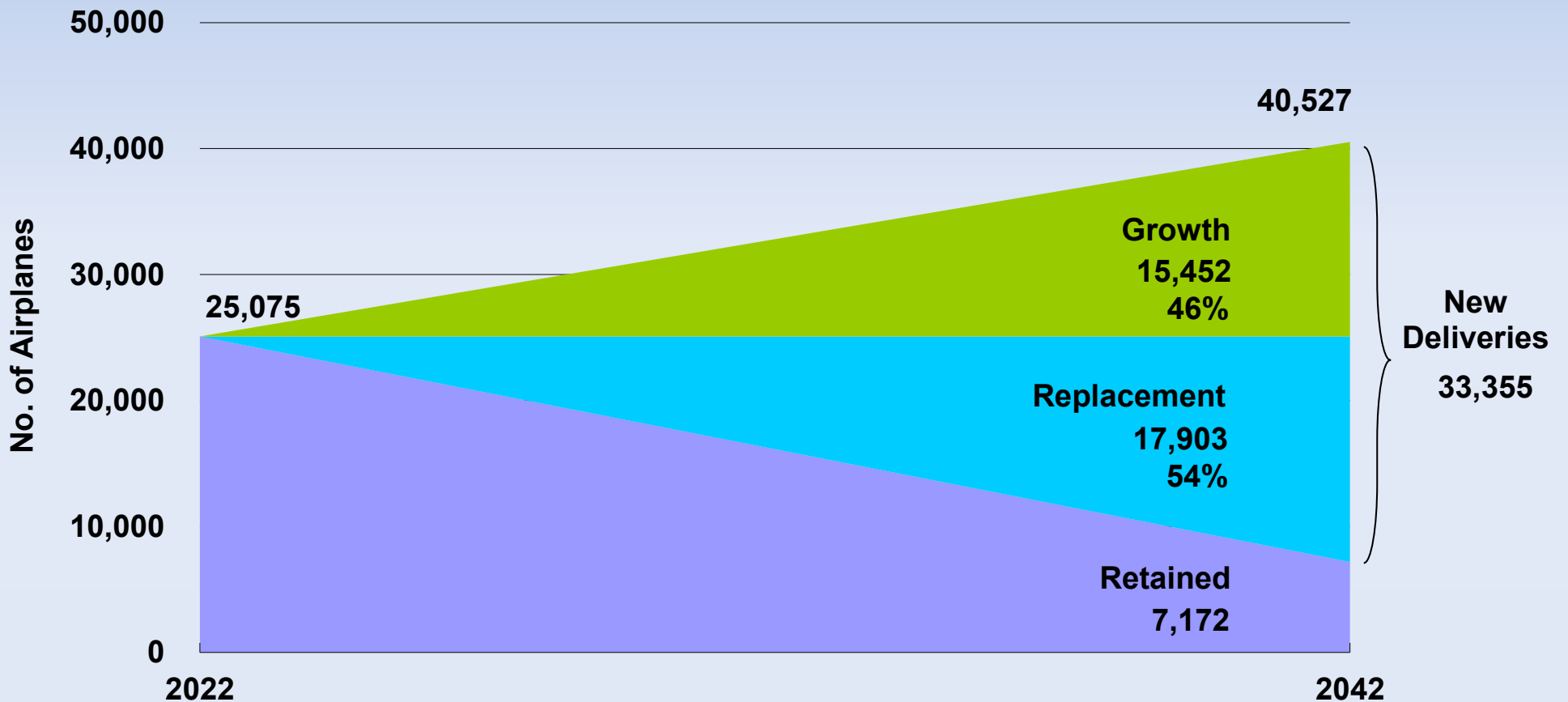
[RPK] Comparison of Shares by Region

Asia-Pacific Airlines to have more market shares. Middle East to slow down.



World Passenger Jet Fleet Forecast

Airlines will need 33,355 passenger jet planes, valued at \$ 5.5 trillion in the next 20 years,

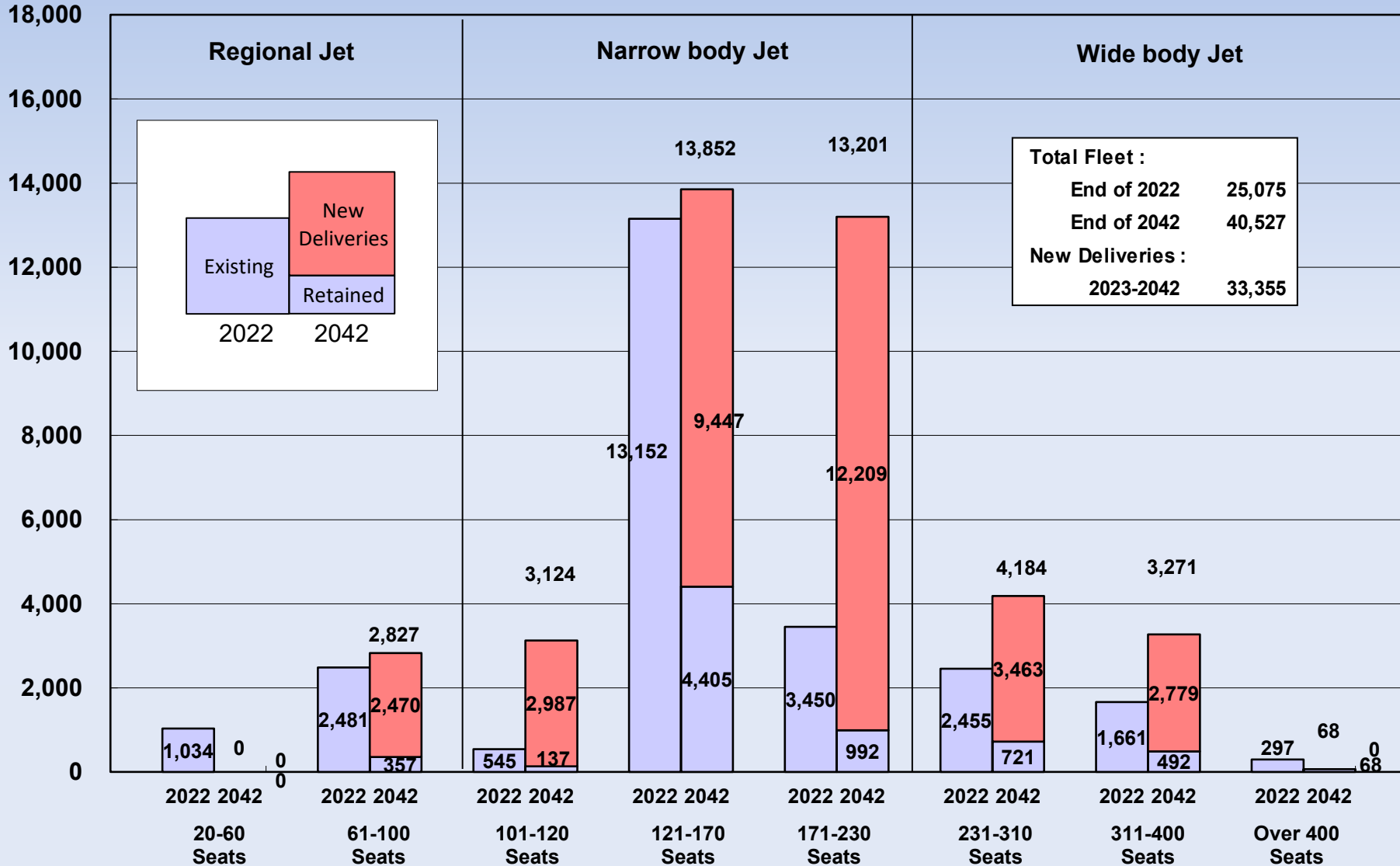


The 25,075 aircrafts in 2022 includes the number of young aircrafts in Storage status. They are likely to return to In-Service status.

World Passenger Jet Fleet Forecast by Seat category

Primary market to be found in 171-230 Seats class.

No. of
Airplanes



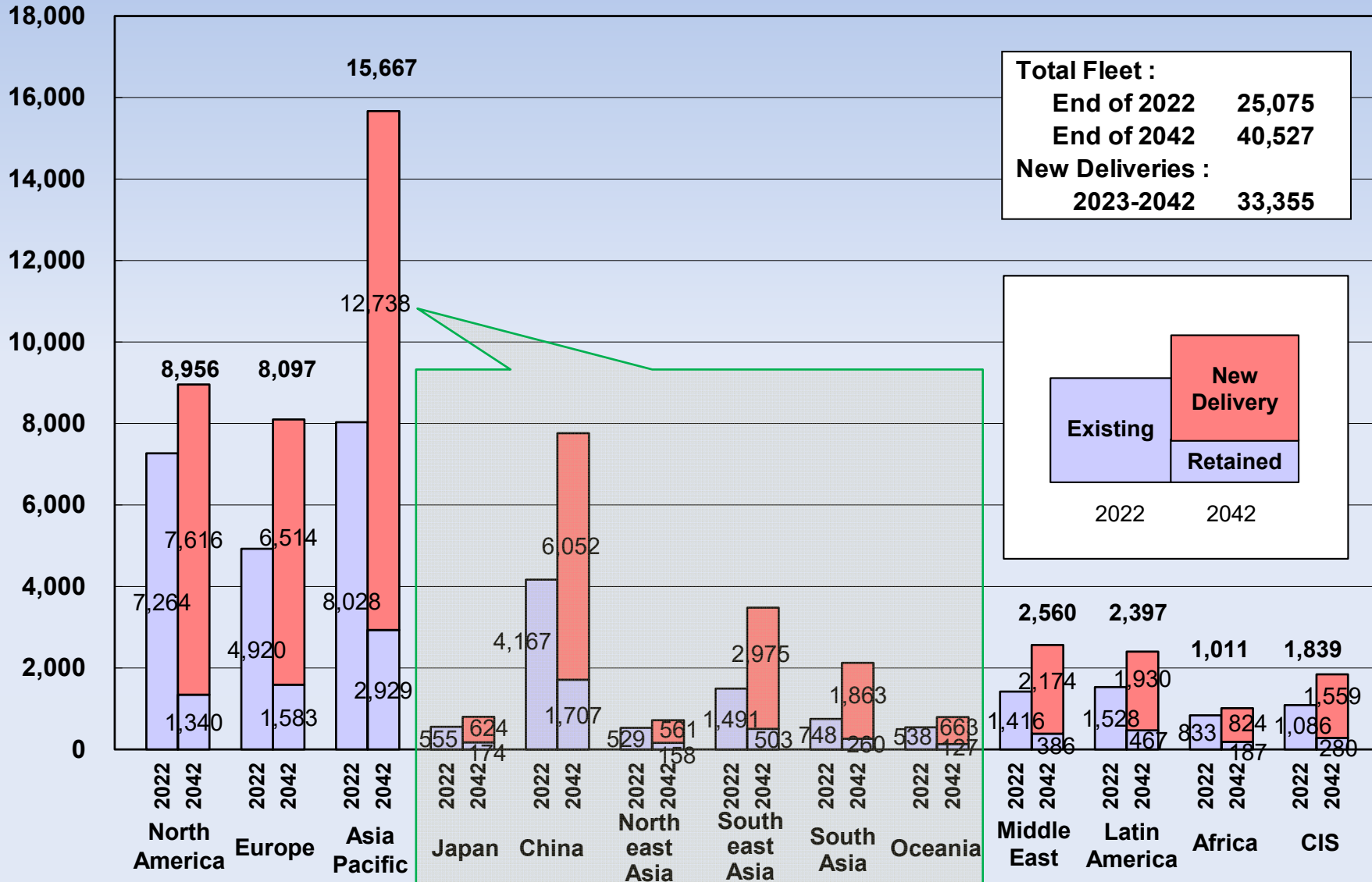
Total Fleet :	
End of 2022	25,075
End of 2042	40,527
New Deliveries :	
2023-2042	33,355

World Passenger Jet Fleet Forecast by Region

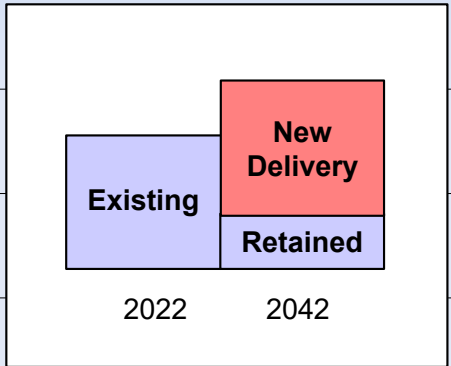
Europe, North America and China

to constitute three pillars for the world market.

No. of Airplanes



Total Fleet :	
End of 2022	25,075
End of 2042	40,527
New Deliveries :	
2023-2042	33,355

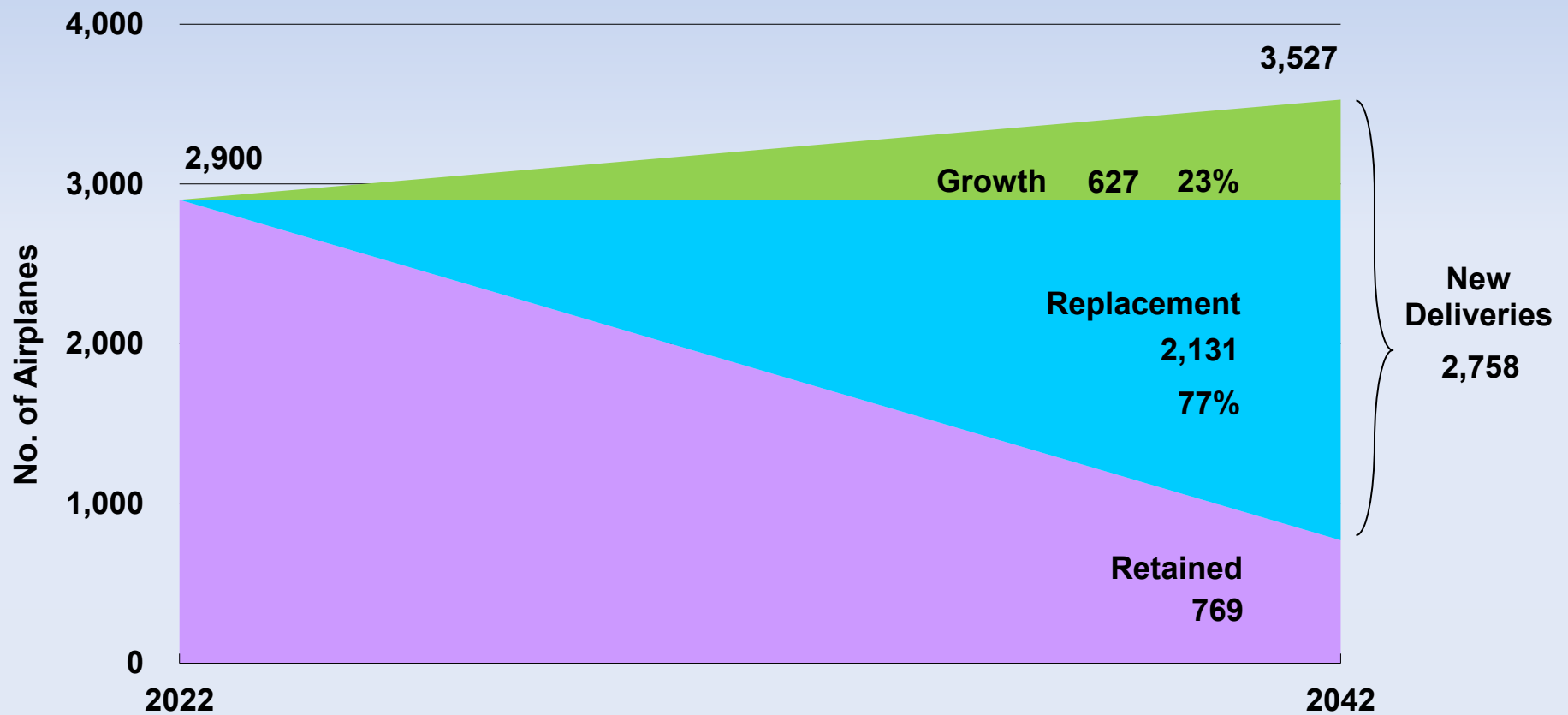


Classification of main passenger planes

Category	Size (seats)	Aircraft
Turbo prop	15-40	DHC6-400, Do228, SkyCourier, ES-30
	41-80	ATR42/72, DHC8-400, MA60
	81-100	(ATR92)
Jet	20-60	CRJ200/440, ERJ135/140/145
	61-100	CRJ700/900/1000 E170/175E2/190E2, ARJ21, SSJ100,
	101-120	A220-100, E195E2 A318, B737-600
	121-170	A319ceo/neo, A320ceo/neo, A220-300, B737MAX-7/-8, C919
	171-230	A321ceo/neo, B737MAX-9/-10 B757
	231-310	A330-800/-900, B787-8/-9 A300-600, B767-300/-400
	311-400	A350-900/-1000, B777/X, B787-10 A340
	401-500	B747
	>500	A380

World Turboprop Fleet Forecast

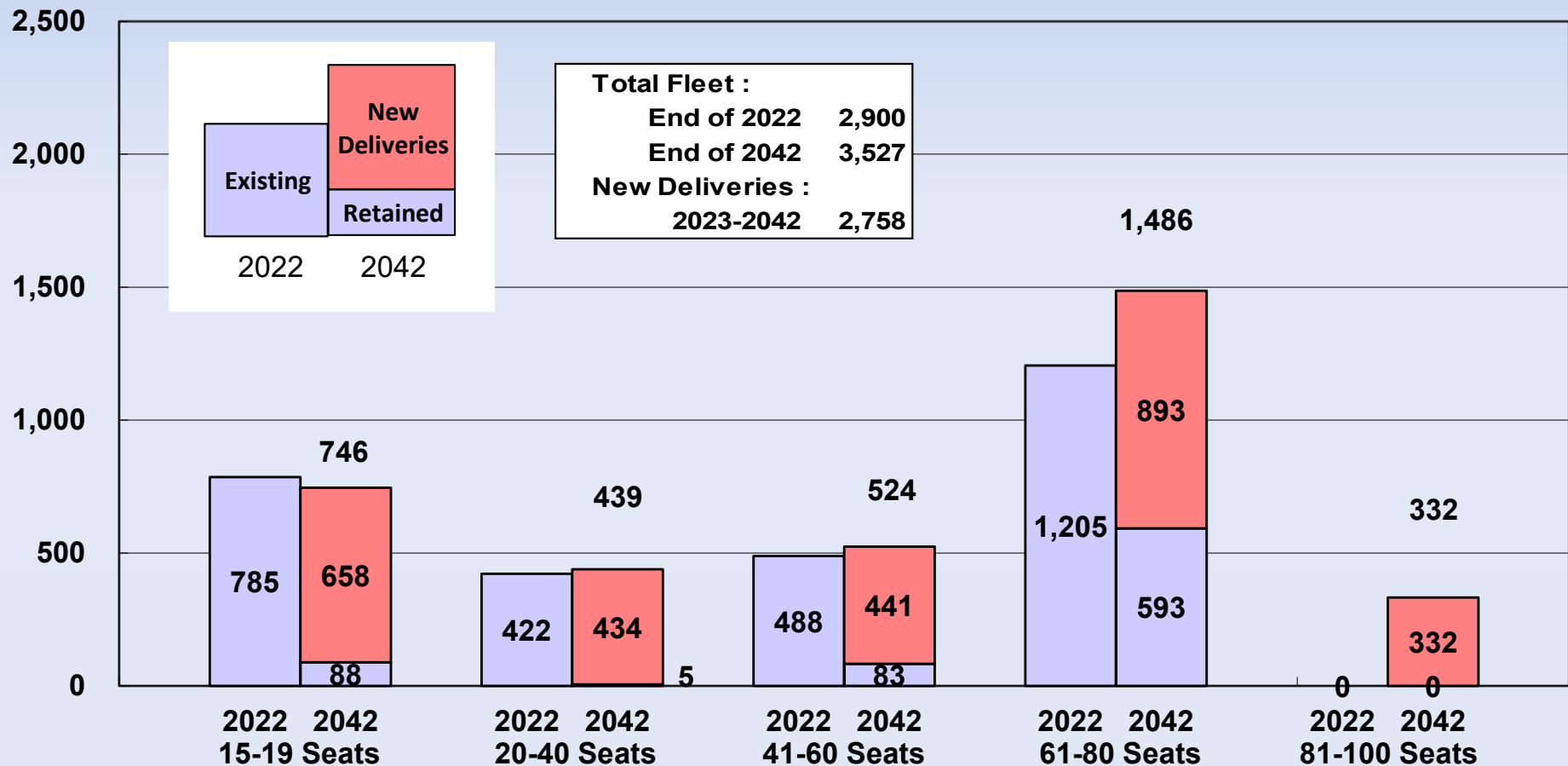
Airlines will need 2,758 passenger turboprop airplanes, valued at \$59 billion in the next 20 years.



World Turboprop Fleet Forecast by Seat category

The 15-19 seats category will have New Type of plane, 408 SkyCourier. This is the first new aircraft in this class in a long time. In the 20-40 seat class, EIS for the ES-30 electric aircraft is scheduled in 2028. It is expected to replace aging planes.

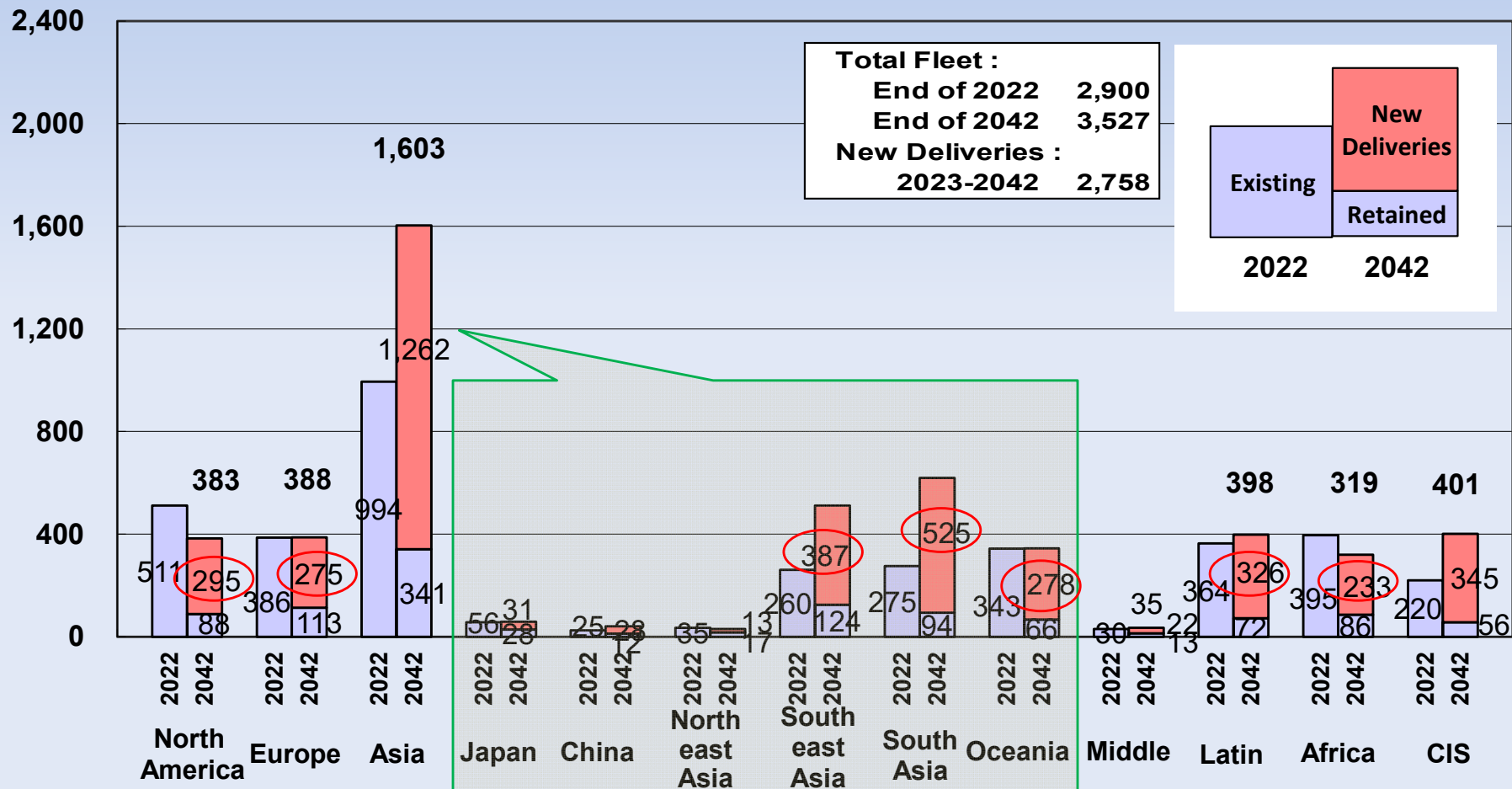
No. of Airplanes



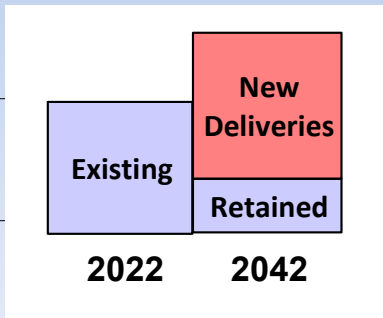
World Turboprop Fleet Forecast by Region

The demand for turboprop planes to be widespread in many regions.

No. of Airplanes



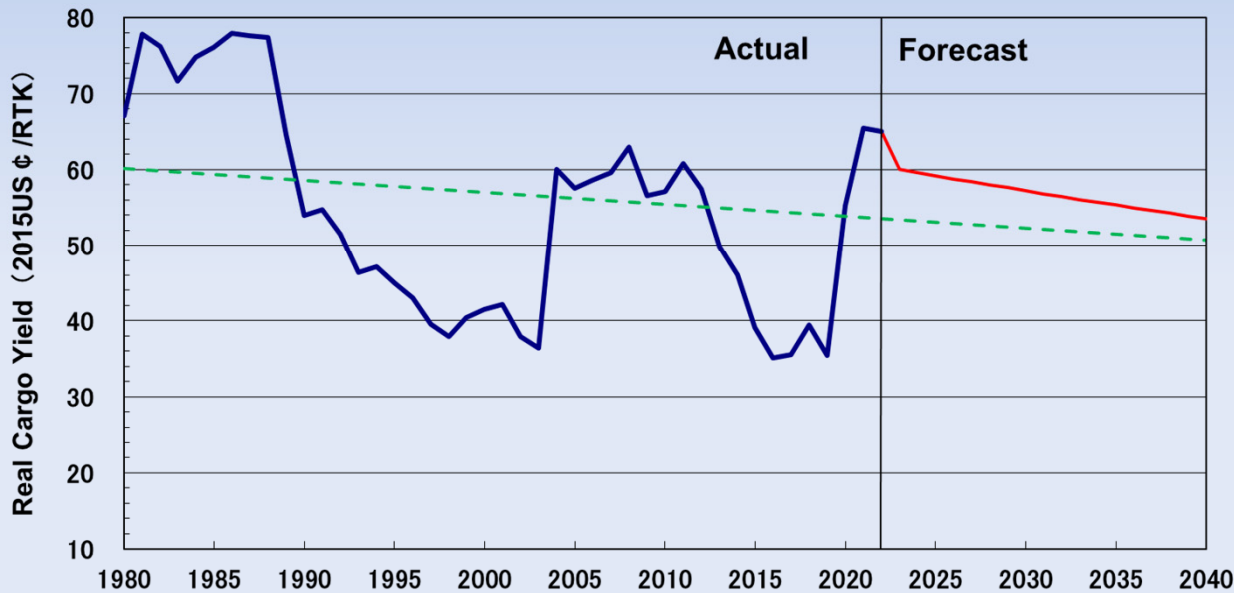
Total Fleet :	
End of 2022	2,900
End of 2042	3,527
New Deliveries :	
2023-2042	2,758



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Air Cargo Traffic and Freighter Fleet Forecast

Trend of Real Cargo Yield

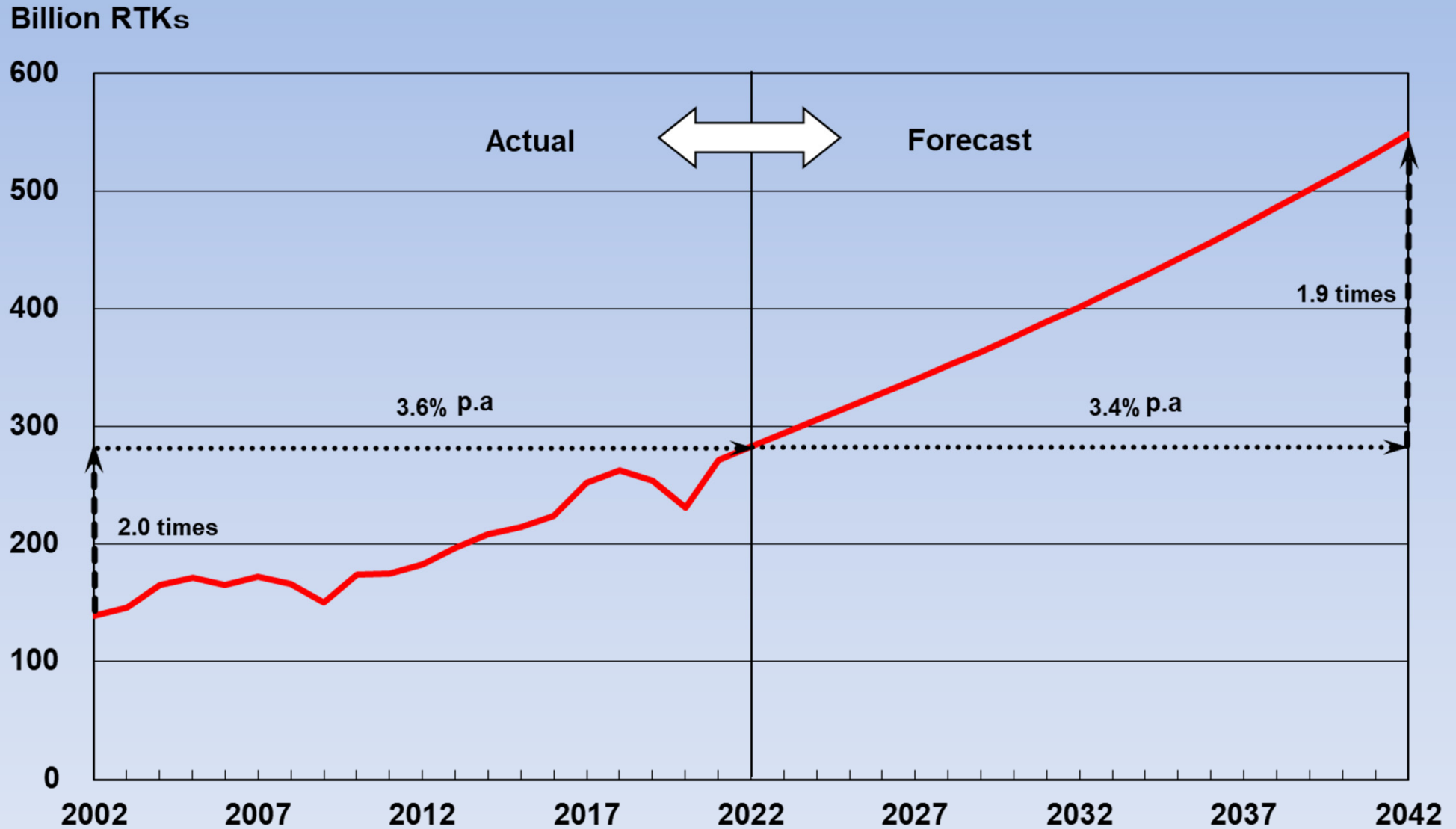


World average real cargo yield will decline by 0.26% annually.

Narrowbody (<50 tonnes)	Medium Widebody (50-70 tonnes)	Large (>70 tonnes)
B Ae-146	DC-10-10	DC-10-30/40
CRJ100/200	767	MD-11
DC-8	A300	777
DC-9	A310	747
MD-80	A330	A380
MD-90	IL-76	An-124
727		
737		
757		
A320		
A321		
Tu-204		

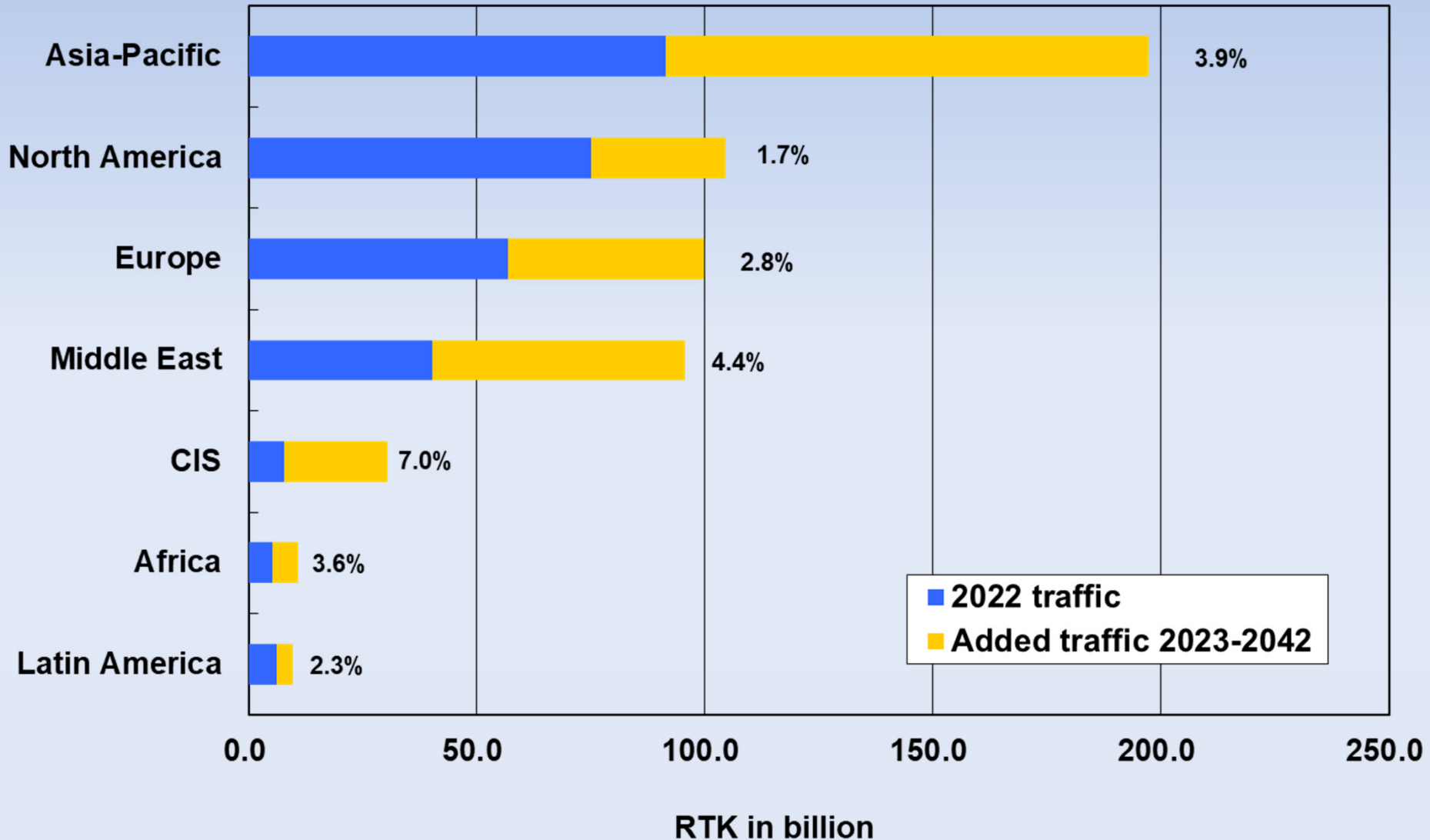
[RTK] World Air Cargo Traffic Forecast

World air cargo traffic forecast to grow 3.4% per year through 2042.



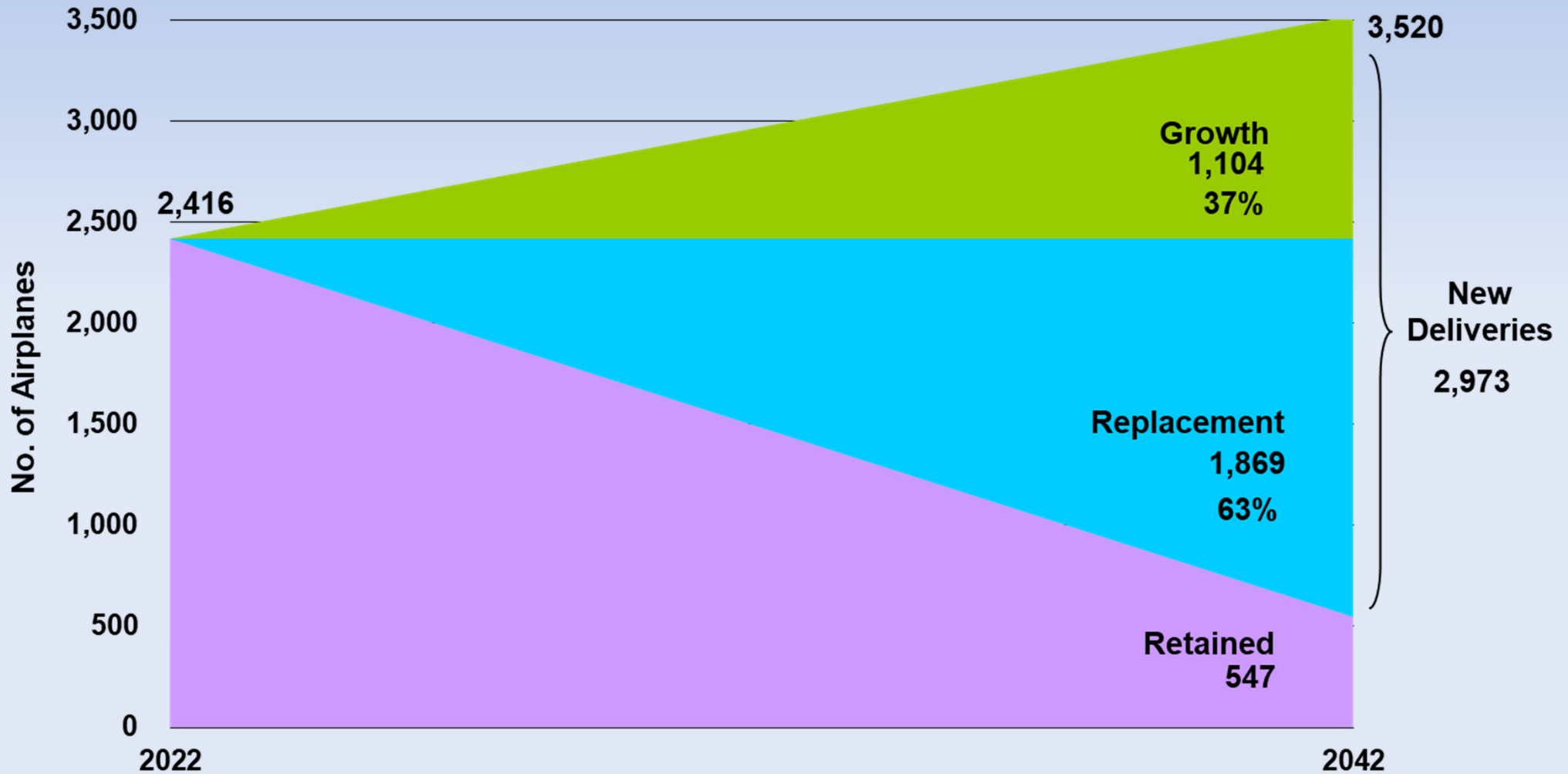
JADC [RTK] World Air Cargo Traffic Forecast by Region

Growth rate of air cargo demand varies by region.



Jet Freighter Fleet Forecast

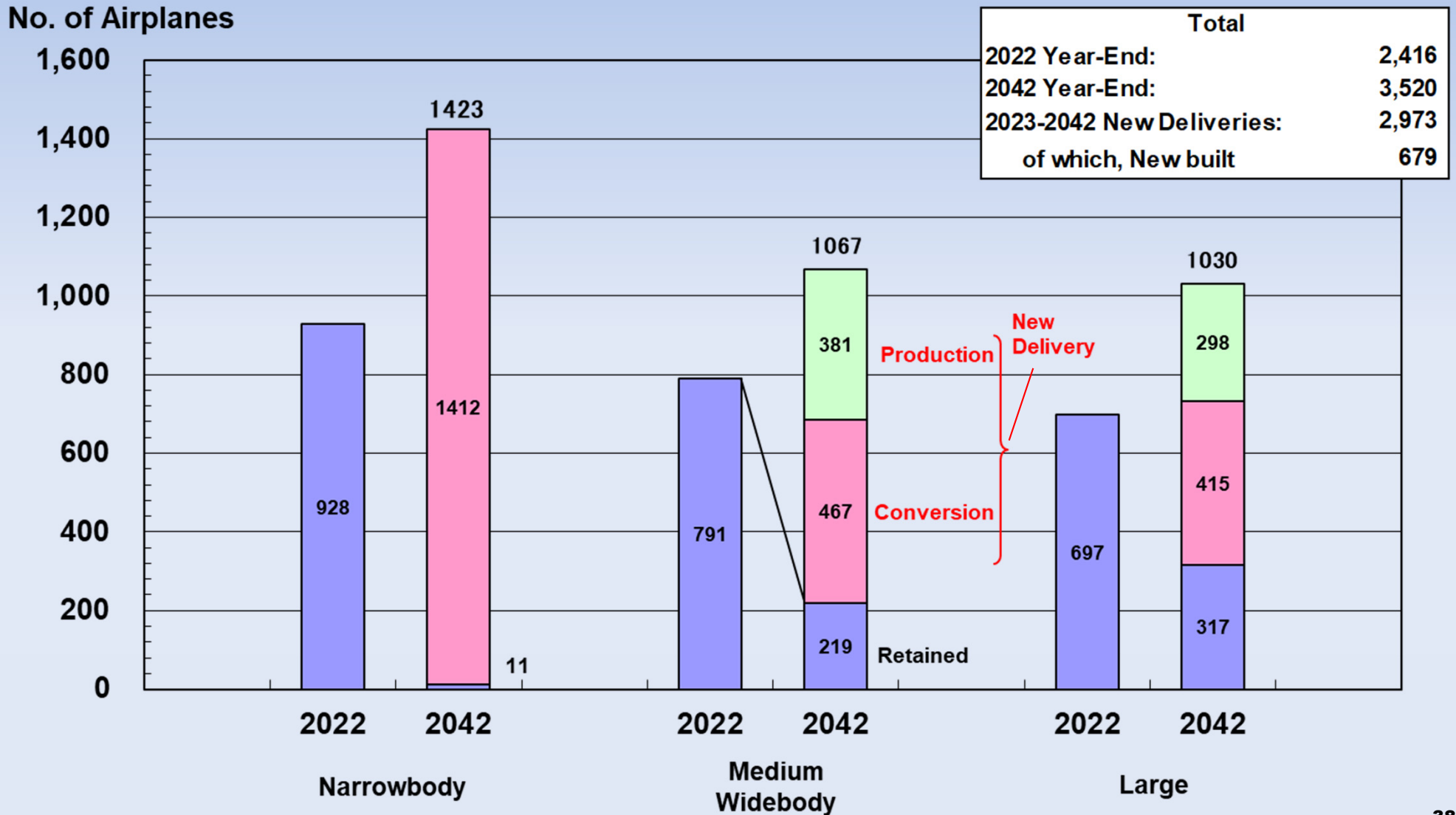
New deliveries will be 2,973 planes.
Of which, Growth 1,104.





Jet Freighter Fleet Forecast by Size Category

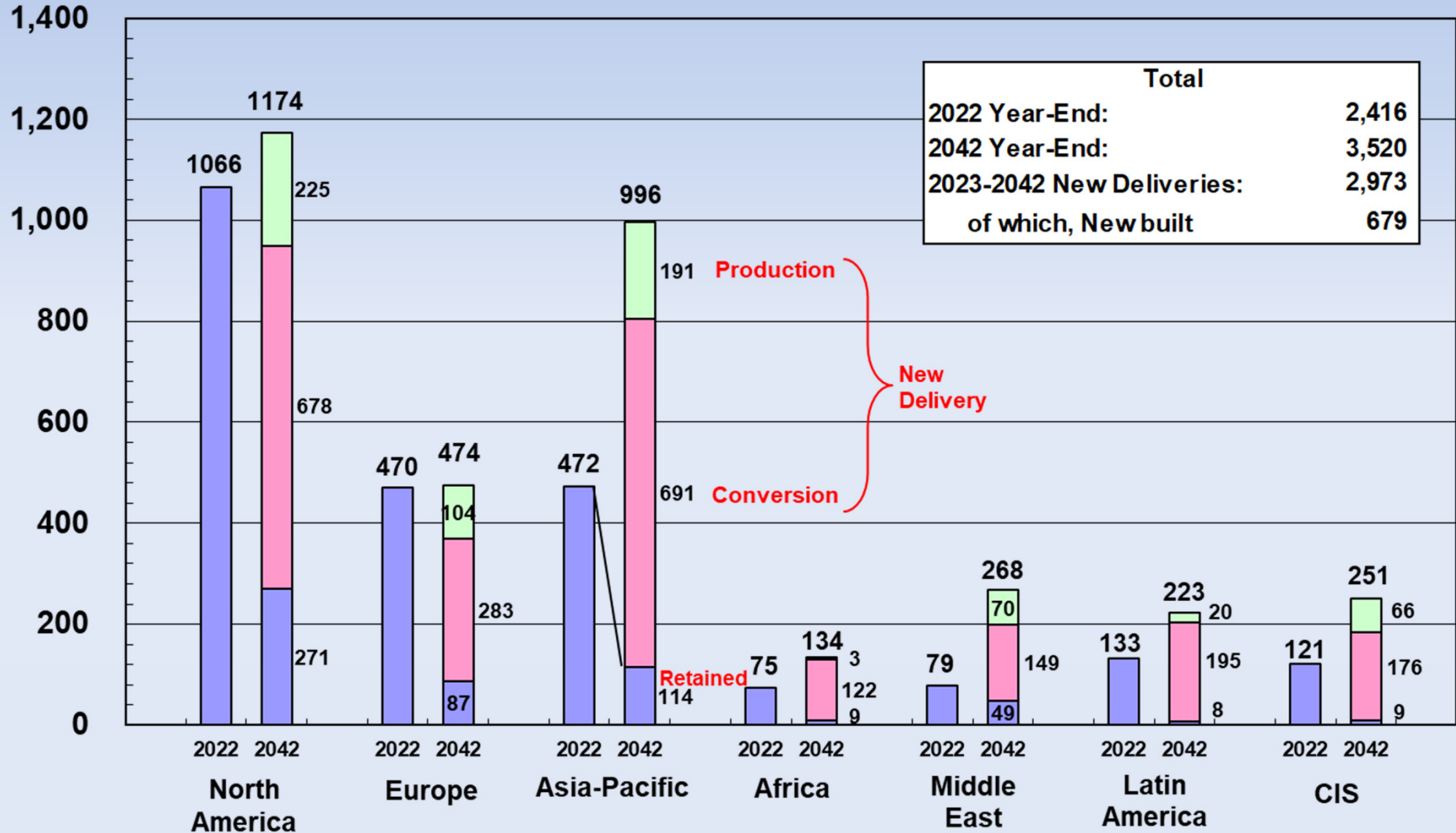
New built freighter will be 679 planes. Widebody planes only.



Jet Freighter Fleet Forecast by Region

North America, Asia-Pacific Airlines will need more new built freighter planes.

No. of Airplanes



Summary

	2019 actual	2022 actual	2042 forecast	Growth Rate	Sales (2019 US\$billion)
World Economic Growth (GDP)				2.47%p.a. *2042	
				2.58%p.a. *2342	
Passenger Demand (RPK : × 10 ⁹ passenger km)	8,486	5,991 * I	18,361	3.4%p.a. *2042	
Passenger Jet Airplane Fleet	24,015 *	25,075 * +	40,527	2.4%p.a. *2342	
New Passenger Jet Airplane Deliveries			33,355		5,229 *2342
Cargo Demand (RTK : × 10 ⁹ ton km)	253	249 * I	547	3.4%p.a. *2042	
Jet Freighter Fleet	2,023 *	2,414 *	3,520	1.9%p.a. *2342	
New Jet Freighter Deliveries			679		229 *2342
Total New Jet Airplane Deliveries			34,034		5,458 *2342
Passenger Turboprop Airplane Fleet	3,583 *	2,900 * +	3,527	1.0%p.a. *2342	
New Passenger Turboprop Airplane Deliveries			2,758		59 *2342
New Engine Deliveries			81,659		1,201 *2342

(* : A numerical value with * are based on the database of Cirium.) (+ : A numerical value with + includes part of aircraft of Storage in addition to that of In Service.)

(*2042 : A numerical value with *2042 indicates a figure for the period 2020 to 2042.) (*2342 : A numerical value with *2342 indicates a figure for the period 2023 to 2042.)

(*I : A numerical value with *I is based on a preliminary figure by IATA.)

For more information, visit our website:

<http://www.jadc.jp/en/data/forecast/> (English)

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